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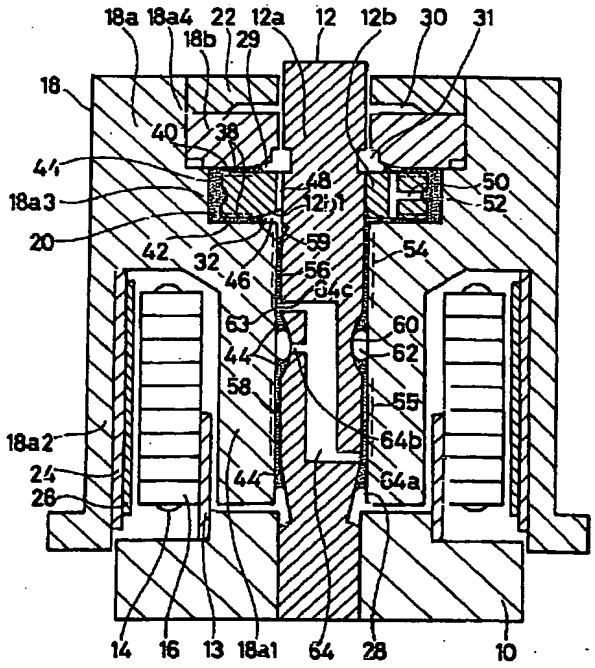
(54)【発明の名称】　動圧流体軸受装置及び電動機

(57)【要約】
【課題】　スラスト軸受部及びラジアル軸受部の一方のみに潤滑液不足が生じて装置が短寿命化することを防ぐ。スラスト軸受部に保持された潤滑液が回転スリーブ体の回転時にラジアル軸受部へ過剰に移動してスラスト軸受部を潤滑する潤滑液の量が過少になることを防ぐ。
【解決手段】　固定スラスト板１２ｂの下側内周側部１２ｂ１における１８０度中心角を隔てた２箇所に、径方向の連絡突条部３４を設ける。連絡突条部３４の内端面と固定軸部材１２ａの外周面との間にスリット部３６を有する。連絡突条部３４とスラスト溝部２０の下側面との間に径方向の連絡路３７を有する。連絡路３７に潤滑油４４が表面張力により保持され、固定軸部材１２ａとスリーブ部１８ａ１との間隙に保持された潤滑油４４の上端部と下スラスト軸受部４２に保持された潤滑油４４の内周部が連続する。



【特許請求の範囲】
【請求項１】軸部とその軸部から径方向外方へ張り出したスラスト部とを有してなる固定軸体に対し、前記軸部のうちスラスト部よりも基端側の部分にスリーブ嵌合したスリーブ部と、前記スラスト部の基端側の面に軸心方向基端側において相対する回転スラスト面とを有してなる回転スリーブ体が、前記固定軸体と回転スリーブ体との間隙に充填された潤滑液を介し、主に軸部とスリーブ部が相対するラジアル軸受部及び回転スラスト面とスラスト部が相対するスラスト軸受部において、回転自在に支持されてなる動圧流体軸受装置であって、前記スラスト部の基端側の面と回転スラスト面が相対する部分に有する基端側スラスト軸受部の内周側に、スラスト部の基端側の面と回転スラスト面との軸心方向間隙が前記基端側スラスト軸受部よりも大きい基端側軸心方向間隙拡大部を有し、その基端側軸心方向間隙拡大部の一部に、潤滑液が表面張力により保持され得る程度に軸心方向間隙が狭く、保持された潤滑液が、基端側スラスト軸受部に保持された潤滑液の内周部と、軸部とスリーブ部の間隙に保持された潤滑液の先端部との間に連続し得る連絡路を有し、前記基端側軸心方向間隙拡大部の前記連絡路以外の部分のうち少なくとも内周部が気体部分であり、その気体部分と外部とを連通する呼吸孔を固定軸体内に有し、ラジアル軸受部に保持されて先端側が基端側軸心方向間隙拡大部に臨む潤滑液が基端向きに移動した場合に連絡路による潤滑液の連続が途切れることを特徴とする動圧流体軸受装置。
【請求項２】基端側軸心方向間隙拡大部が、径方向内方に向かって軸心方向間隙が漸次拡大するものであり、この基端側軸心方向間隙拡大部に、基端側スラスト軸受部に保持された潤滑液の径方向内方の界面が位置する請求項１記載の動圧流体軸受装置。
【請求項３】上記連絡路が、スラスト部の基端側の面に設けられて基端向きに突起する、ほぼ径方向に連続する突起部と、回転スラスト面の間に形成され、その突起部の径方向内端部に、周方向両方及び軸心方向基端向きに開口し、潤滑液を表面張力により保持し得るスリット部を有する請求項１又は２記載の動圧流体軸受装置。
【請求項４】ラジアル軸受部として、先端側がスラスト部の基端側の面と回転スラスト面との間隙に近接した先端側ラジアル軸受部と、その先端側ラジアル軸受部よりも基端側に位置する基端側ラジアル軸受部を有し、前記先端側ラジアル軸受部と基端側ラジアル軸受部の間に、軸部の外周面とスリーブ部の内周面との径方向間隙が両ラジアル軸受部よりも大きい中間径方向間隙拡大部を有し、その中間径方向間隙拡大部は、前記先端側ラジアル軸受部から基端側に向かって漸次径方向間隙が拡大する第１間隙拡大部と、前記基端側ラジアル軸受部から先端側に向かって漸次径方向間隙が拡大する第２間隙拡大部を有し、先端側ラジアル軸受部に保持された潤滑液の基端側の界面を前記第１間隙拡大部に有すると共に、基端側ラジアル軸受部に保持された潤滑液の先端側の界面を前記第２間隙拡大部に有し、中間径方向間隙拡大部における第１間隙拡大部と第２間隙拡大部の中間部付近と外部とを、少なくとも回転スリーブ体の回転時に連通する通気孔を前記固定軸体内に備え、軸部の外周面における先端側ラジアル軸受部の基端側と第１間隙拡大部との境界部付近に、径方向外方開口の周方向の基端側円弧状溝部を有し、その基端側円弧状溝部と外部とを、少なくとも回転スリーブ体の回転時に連通する通気孔を、前記固定軸体内に備える請求項１、２又は３記載の動圧流体軸受装置。
【請求項５】スラスト部に外嵌する径方向内方開口の環状のスラスト溝部を回転スリーブ体が有し、そのスラスト溝部の基端側の面及び先端側の面をそれぞれ回転スラスト面とし、スラスト部の先端側の面と先端側の回転スラスト面が相対する部分と、スラスト部の基端側の面と基端側の回転スラスト面が相対する部分の両方にスラスト軸受部を有し、先端側スラスト軸受部と基端側スラスト軸受部の潤滑液は、スラスト部の外周端面とスラスト溝部の外周部の間の部分を介して連続し、先端側及び基端側の各スラスト軸受部に、各スラスト軸受部における潤滑液が回転スリーブ体の回転に伴い内周側から外周側へ移動する圧力分布を生じさせる動圧発生機構を有し、先端側スラスト軸受部の径方向内方に潤滑液の先端界面を有し、スラスト部の外周端面、並びにスラスト部の先端側の面及び基端側の面のうち先端側及び基端側のスラスト軸受部の内周側の部分において、それぞれスラスト溝部とスラスト部の間隙に充填された潤滑液内に開口する潤滑液循環路をスラスト部内に有する請求項１、２、３又は４記載の動圧流体軸受装置。
【請求項６】請求項１、２、３、４又は５記載の動圧流体軸受装置を備え、回転スリーブ体がロータとして回転する電動機。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、軸部から張り出したスラスト部を有してなる固定軸体に対し回転スリーブ体が潤滑液を介し回転自在に支持されてなる動圧流体軸受装置及びその動圧流体軸受装置を備えた電動機、特に、スラスト軸受部及びラジアル軸受部の一方のみについて潤滑液不足が生じて装置が短寿命化するという不都合の発生が防がれると共に、スラスト軸受部に保持された潤滑液がラジアル軸受部へ過剰に移動してスラスト軸受部を潤滑する潤滑液の量が過少になることが防がれる動圧流体軸受装置及びその動圧流体軸受装置を備えた電動機に関する。
【０００２】
【従来の技術及び発明が解決しようとする課題】図４は、軸部ａから張り出したスラスト板部ｂを有する上下

方向の固定軸体ｃに対しロータとしての回転スリーブ体ｄが潤滑油ｅ（潤滑液）を介し回転自在に支持された動圧流体軸受装置を備えたハードディスク駆動用のスピンドルモータ（電動機）の従来例についての断面図である。

【０００３】固定軸体ｃは、下端部（基端部）が基盤ｆに固定されており、上端部（先端部）は、ハードディスク駆動装置の蓋体等に固定される。回転スリーブ体ｄのスリーブ部ｄ１は、固定軸体ｃの軸部ａのうちスラスト板部ｂよりも基端側の部分にスリーブ嵌合し、環状のスラスト溝部ｇは、径方向内方に開口し、スラスト板部ｂに外嵌している。

【０００４】このような従来の動圧流体軸受装置を備えたスピンドルモータにおいて、スラスト板部ｂとスラスト溝部ｇの間隙に形成されるスラスト軸受部ｋの潤滑油ｅと、スリーブ部ｄ１と軸部ａの間隙に形成されるラジアル軸受部ｉの潤滑油ｅとが連続している場合に、回転スリーブ体ｄの回転時に、公差、組立、熱変形等の要因により、ラジアル軸受部ｉの潤滑油ｅが下向き（基端向き）に移動すると、それに連続するスラスト軸受部ｋの潤滑油ｅも共に移動するので、移動量が大きくなればスラスト軸受部ｋの潤滑油ｅが不足することとなり、回転精度が低下したり、軸受装置、すなわちスピンドルモータが短寿命化するという不都合が発生する。

【０００５】一方、スラスト板部ｂの基端側の面とスラスト溝部ｇの基端側の面との間隙のうち内周部に環状の気体部分ｍを有し、スラスト軸受部ｋの潤滑油ｅとラジアル軸受部ｉの潤滑油ｅとが分離している場合、何れか一方の軸受部に蒸発や衝撃による脱落等により潤滑油ｅが減少すると、その一方のみの軸受部に生じた潤滑油不足により回転精度が低下したり、軸受装置全体、すなわちスピンドルモータ全体が短寿命化するという不都合が発生する。

【０００６】また、回転スリーブ体ｄの回転時に、公差、組立、熱変形等の要因により、ラジアル軸受部ｉの潤滑油ｅが上向き（先端向き）に移動し過ぎると、ラジアル軸受部ｉの潤滑油ｅが不足することが生じ得る。

【０００７】更に、回転スリーブ体ｄの回転時には、スラスト溝部ｇとスラスト板部ｂの間隙の外周部付近に気泡が溜まり易く、然もその気泡は外部へ解放され難い。このような気泡は、熱により膨張して潤滑油ｅを外部へ漏出させる原因ともなる。

【０００８】本発明は、従来技術に存した上記のような問題点に鑑み行われたものであって、その第１の目的は、スラスト軸受部及びラジアル軸受部の一方のみについて潤滑液不足が生じて装置が短寿命化するという不都合の発生が防がれると共に、スラスト軸受部に保持された潤滑液が回転スリーブ体の回転時にラジアル軸受部へ過剰に移動してスラスト軸受部を潤滑する潤滑液の量が過少になることが防がれる動圧流体軸受装置及び電動機を提供することにある。

【０００９】また第２の目的は、回転スリーブ体の回転時における先端向きの潤滑液移動圧力によるラジアル軸受部の潤滑液の先端側への移動量が抑えられ、ラジアル軸受部の潤滑液不足が防がれる動圧流体軸受装置及び電動機を提供することにある。

【００１０】更に第３の目的は、スラスト溝部とスラスト板部の間隙の外周部付近の気泡を外部へ解放することができる動圧流体軸受装置及び電動機を提供することにある。

【００１１】

【課題を解決するための手段】(1)　本発明の動圧流体軸受装置は、軸部とその軸部から径方向外方へ張り出したスラスト部とを有してなる固定軸体に対し、前記軸部のうちスラスト部よりも基端側の部分にスリーブ嵌合したスリーブ部と、前記スラスト部の基端側の面に軸心方向基端側において相対する回転スラスト面とを有してなる回転スリーブ体が、前記固定軸体と回転スリーブ体との間隙に充填された潤滑液を介し、主に軸部とスリーブ部が相対するラジアル軸受部及び回転スラスト面とスラスト部が相対するスラスト軸受部において、回転自在に支持されてなる動圧流体軸受装置であって、前記スラスト部の基端側の面と回転スラスト面が相対する部分に有する基端側スラスト軸受部の内周側に、スラスト部の基端側の面と回転スラスト面との軸心方向間隙が前記基端側スラスト軸受部よりも大きい基端側軸心方向間隙拡大部を有し、その基端側軸心方向間隙拡大部の一部に、潤滑液が表面張力により保持され得る程度に軸心方向間隙が狭く、保持された潤滑液が、基端側スラスト軸受部に保持された潤滑液の内周部と、軸部とスリーブ部の間隙に保持された潤滑液の先端部との間に連続し得る連絡路を有し、前記基端側軸心方向間隙拡大部の前記連絡路以外の部分のうち少なくとも内周部が気体部分であり、その気体部分と外部とを連通する呼吸孔を固定軸体内に有し、ラジアル軸受部に保持されて先端側が基端側軸心方向間隙拡大部に臨む潤滑液が基端向きに移動した場合に連絡路による潤滑液の連続が途切れることを特徴とする（請求項１）。

【００１２】固定軸体を構成する軸部とスラスト部は、一体に形成されたものであってもよく、別体の部品を結合してなるものであってもよい。

【００１３】スラスト軸受部及びラジアル軸受部には、それぞれ動圧発生用の溝部を有することが望ましい。

【００１４】ラジアル軸受部（先端側ラジアル軸受部と基端側ラジアル軸受部に別れている場合は先端側ラジアル軸受部）は、公差範囲程度でやや先端寄りに潤滑液の動圧が高くなるアンバランスを生じするよう設計することができる。

【００１５】潤滑液としては、例えばスピンドル油等の各種潤滑油を用いることができる。

【００１６】基端側軸心方向間隙拡大部の少なくとも内周部は、潤滑液をスラスト部の基端側の面と回転スラスト面の軸心方向間隙が、両者間に潤滑液を表面張力により保持し得ない程度に大きいことが好ましい。

【００１７】連絡路は、例えば、基端側軸心方向間隙拡大部の一部に、スラスト部の基端側の面及び回転スラスト面の一方の面又は両方の面に、好ましくはスラスト部の基端側の面に、軸心方向に突起して両面の軸心方向間隙を基端側軸心方向間隙拡大部の他の部分よりも狭くする、ほぼ径方向に連続する突起部（例えばほぼ径方向の突条部）を形成することにより設けることができる。この突起部を前記一方の面に設けて他方の面との間を連絡路とすることができるほか、前記両方の面に軸心方向に相対する突起部を設けて両突起部の間を連結路とすることもできる。基端側スラスト軸受部から径方向内方に向かう連絡路は１つでもよく２以上でもよい。

【００１８】基端側スラスト軸受部に保持された潤滑液の内周部と、軸部とスリーブ部の間隙に保持された潤滑液の先端部との間が、連絡路に保持された潤滑液により連続する。基端側スラスト軸受部とラジアル軸受部の何れかにおいて蒸発や衝撃による脱落等により潤滑液が減少した場合、潤滑液が減少した軸受部に対し他方の軸受部から、連絡路を介して潤滑液が補給される。そのため、一方の軸受部のみについて潤滑液不足が生じて装置が短寿命化するという不都合の発生が防がれる。

【００１９】回転スリーブ体の回転時に、公差、組立、熱変形等の要因により、軸部とスリーブ部の間隙に保持されて先端側が基端側軸心方向間隙拡大部に臨む潤滑液に基端向きに移動する圧力が発生し、その潤滑液が基端向きに移動することがあり得る。その場合、基端向き移動圧力が限度を超えると、連絡路における潤滑液に対する遠心力や表面張力等とも作用し合って、基端側スラスト軸受部に保持された潤滑液の内周部と、軸部とスリーブ部の間隙に保持された潤滑液の先端部との間の、連絡路による潤滑液の連続が途切れることとなる。それにより、基端側スラスト軸受部に保持された潤滑液がラジアル軸受部へ過剰に移動して基端側スラスト軸受部を潤滑する潤滑液の量が過少になることが防がれる。また、このように潤滑液が途切れて先端側からラジアル軸受部に気体が導入されれば、それにより基端向きの潤滑液移動圧力が減少してバランスするようになるので、潤滑液の基端側への移動が抑えられる。

【００２０】前記のような軸部とスリーブ部の間隙に保持された潤滑液に対する基端向き移動圧力が回転中に又は回転停止により解消されれば、基端側スラスト軸受部に保持された潤滑液の内周部と、軸部とスリーブ部の間隙に保持された潤滑液の先端部との間の、連絡路による潤滑液の連続が回復し得る。

【００２１】基端側軸心方向間隙拡大部の気体部分の拡大又は縮小に伴い、呼吸孔を通じて気体の移動が生じる。

【００２２】呼吸孔は、潤滑液がその呼吸孔の内部を閉塞した状態で呼吸孔内に表面張力（毛細管現象）により保持されることが防がれる程度に大きい横断面サイズであるものとすることが好ましい。この場合、呼吸孔の内部を閉塞した状態で潤滑液が表面張力により呼吸孔内に保持されることが防がれるので、呼吸孔を通じた気体の移動が確実性高く行われ、また潤滑液に混入した気泡等の呼吸孔を通ずる外部への解放が確実性高く行われ得る。

【００２３】なお、この動圧流体軸受装置は、軸部の外周面におけるスリーブ部の先端部に相対する位置の上記連絡路が存在しない周方向部分に、径方向外方開口の周方向の先端側円弧状溝部を有するものとすることができる。

【００２４】この先端側円弧状溝部とスリーブ部の内周面との間に形成される周方向の円弧状径方向間隙拡大部に、ラジアル軸受部に保持された潤滑液の先端側界面が表面張力により位置し、その周方向部分において、ラジアル軸受部に保持された潤滑液がスラスト部の基端側の面と回転スラスト面との間隙に流入することが防がれる。

【００２５】回転スリーブ体の回転時に、公差、組立、熱変形等の要因により、軸部とスリーブ部の間隙に保持されて先端側が基端側軸心方向間隙拡大部に臨む潤滑液に基端向きに移動する圧力が発生し、その基端向き移動圧力が限度を超えることにより連絡路による潤滑液の連続が途切れた場合に、前記の周方向の円弧状径方向間隙拡大部を通じて先端側からラジアル軸受部に気体が導入され易いので、潤滑液の基端側への移動がより確実に抑えられる。

【００２６】また、この動圧流体軸受装置は、スラスト部（例えば環状のスラスト板部）に外嵌する径方向内方開口の環状のスラスト溝部を回転スリーブ体が有し、スラスト溝部の基端側の面及び先端側の面をそれぞれ回転スラスト面とし、スラスト部の先端側の面と先端側の回転スラスト面が相対する部分と、スラスト部の基端側の面と基端側の回転スラスト面が相対する部分の両方にスラスト軸受部を有するものとすることができる。その場合、先端側スラスト軸受部と基端側スラスト軸受部の潤滑液は、スラスト部の外周とスラスト溝部の外周の間の潤滑液を介して連続するものとすることができる。また、先端側スラスト軸受部の径方向内方に、潤滑液の先端界面を有し、この先端界面が径方向内方を向き、ラジアル軸受部の基端側に、潤滑液の基端界面を有し、この基端界面が基端側に向くものとすることができ、このときは、固定軸体の両端部を固定し得るものとすることができる。

【００２７】本発明の動圧流体軸受装置は、電動機の他、種々の機械器具に利用することができる。

(1-1)　(1) の動圧流体軸受装置は、基端側軸心方向間隙拡大部が、径方向内方に向かって軸心方向間隙が漸次拡大するものであり、この基端側軸心方向間隙拡大部に、基端側スラスト軸受部に保持された潤滑液の径方向内方の界面が位置するものとすることができる（請求項２）。

【００２８】この場合、基端側軸心方向間隙拡大部に位置する潤滑液が表面張力により径方向外方すなわち基端側スラスト軸受部側へ確実性高く引き寄せられ、基端側軸心方向間隙拡大部において潤滑液が基端側スラスト軸受部と内周側とに分離することが防がれる。

(2)　(1) 又は(1-1) の動圧流体軸受装置は、上記連絡路が、スラスト部の基端側の面に設けられて基端向きに突起する、ほぼ径方向に連続する突起部と、回転スラスト面の間に形成され、その突起部の径方向内端部に、周方向両方及び軸心方向基端向きに開口し、潤滑液を表面張力により保持し得るスリット部を有するものとすることが好ましい（請求項３）。

【００２９】スリット部は、例えば径方向間隙が基端開口に向かって漸次拡大する楔形状とすることができる。

【００３０】回転スリーブ体の回転時に、公差、組立、熱変形等の要因により、軸部とスリーブ部の間隙に保持されて先端側が基端側軸心方向間隙拡大部に臨む潤滑液に基端向きに移動する圧力が発生し、その潤滑液が基端向きに移動する場合に、基端側スラスト軸受部に保持された潤滑液の内周部と、軸部とスリーブ部の間隙に保持された潤滑液の先端部との間の、連絡路による潤滑液の連続の途切れが、スリット部において開始し易い。そのため、基端側スラスト軸受部に保持された潤滑液がラジアル軸受部へ過剰に移動して基端側スラスト軸受部を潤滑する潤滑液の量が過少になることがより確実に防がれる。

(3)　(1)、(1-1) 又は(2) の動圧流体軸受装置は、ラジアル軸受部として、先端側がスラスト部の基端側の面と回転スラスト面との間隙に近接した先端側ラジアル軸受部と、その先端側ラジアル軸受部よりも基端側に位置する基端側ラジアル軸受部を有し、前記先端側ラジアル軸受部と基端側ラジアル軸受部の間に、軸部の外周面とスリーブ部の内周面との径方向間隙が両ラジアル軸受部よりも大きい中間径方向間隙拡大部を有し、その中間径方向間隙拡大部は、前記先端側ラジアル軸受部から基端側に向かって漸次径方向間隙が拡大する第１間隙拡大部と、前記基端側ラジアル軸受部から先端側に向かって漸次径方向間隙が拡大する第２間隙拡大部を有し、先端側ラジアル軸受部に保持された潤滑液の基端側の界面を前記第１間隙拡大部に有すると共に、基端側ラジアル軸受部に保持された潤滑液の先端側の界面を前記第２間隙拡大部に有し、中間径方向間隙拡大部における第１間隙拡大部と第２間隙拡大部の中間部付近と外部とを、少なくとも回転スリーブ体の回転時に連通する通気孔を前記固定軸体内に備えるものとすることができる。

【００３１】中間径方向間隙拡大部における第１間隙拡大部と第２間隙拡大部は、必ずしも隣接していることを要しない。例えば第１間隙拡大部と第２間隙拡大部の間に径方向間隙が一定である部分を有していてもよい。

【００３２】中間径方向間隙拡大部における第１間隙拡大部及び第２間隙拡大部は、それぞれ軸部の外周面が基端側及び先端側に向かって漸次縮径することにより漸次径方向間隙が拡大するものとすることが好ましい。

【００３３】第１間隙拡大部及び第２間隙拡大部には潤滑液が貯留される。先端側ラジアル軸受部若しくはスラスト軸受部において、又は基端側ラジアル軸受部において、蒸発や衝撃による脱落等により潤滑液が減少した場合に、第１間隙拡大部に貯留された潤滑液は先端側ラジアル軸受部に、第２間隙拡大部に貯留された潤滑液は基端側ラジアル軸受部に、それぞれ補給される。潤滑液の補給に伴い、通気孔を通じて中間径方向間隙拡大部に気体が導入される。

【００３４】また、潤滑液に混入した余分な気泡や、温度上昇や気圧低下等による気泡の膨張分等は、通気孔を通じ外部に解放され得る。

【００３５】この通気孔は、潤滑液がその通気孔の内部を閉塞した状態で通気孔内に表面張力（毛細管現象）により保持されることが防がれる横断面サイズであるものとすることが好ましい。この場合、通気孔の内部を閉塞した状態で潤滑液が表面張力により通気孔内に保持されることが防がれるので、気体の導入は確実性高く行われ、潤滑液に混入した気泡等は、通気孔を通じて確実性高く外部に解放され得る。

【００３６】通気孔の数又は中間径方向間隙拡大部若しくは外部への開口の数はそれぞれ１又は2 以上とすることができる。

(3-1)　(3) の動圧流体軸受装置は、基端側ラジアル軸受部の基端側に、軸部とスリーブ部の間の径方向間隙が基端側に向かって漸次拡大する基端径方向間隙拡大部を有し、この基端径方向間隙拡大部に、基端側ラジアル軸受部に保持された潤滑液の非回転時の基端界面が位置するものとすることができ、更に、この基端界面を回転スリーブ体の回転に伴い先端側へ引き込む界面引込機構を備え、上記通気孔の外部開口が、基端側ラジアル軸受部と基端径方向間隙拡大部の境界部付近に位置して、非回転時には潤滑液中に開口し、回転スリーブ体の回転時には外気に通じるものとすることが好ましい。

【００３７】回転スリーブ体が回転すると、固定軸体と回転スリーブ体との間隙に充填された潤滑液に遠心力が作用する。そのため、非回転時においては基端径方向間隙拡大部に基端界面が位置するように表面張力により保持されていた潤滑液が、前記遠心力の作用によって更に基端側へ滲出若しくは漏出することにより、或いは衝撃により脱落することにより散逸し易い状態となる。とこ

ろが、界面引込機構によって、回転スリーブ体の回転に伴い、潤滑液の基端界面が非回転時の位置から先端側へ引き込まれるので、遠心力の作用による潤滑液の滲出又は漏出による散逸、或いは衝撃により脱落することによる散逸が生じ難くなる。

【００３８】上記界面引込機構は、基端側ラジアル軸受部に動圧発生溝部を設け、回転スリーブ体の回転に伴いその動圧発生溝部によって潤滑液に発生する動圧が、その基端側ラジアル軸受部における先端側寄りに偏って高くなるものとすることができる。そのためには、その動圧発生溝部を例えば基端側ラジアル軸受部における軸心方向先端寄りに偏心させた構造を採用し得る。なお、動圧発生溝部の動圧発生溝としては、例えばヘリングボーン溝等を用いることができる。また、動圧発生溝部は、軸部及びスリーブ部の何れか又は両方に設けることができる。

【００３９】一方の開口が中間径方向間隙拡大部における第１間隙拡大部と第２間隙拡大部の中間部付近に位置する通気孔の外部開口は、基端側ラジアル軸受部と基端径方向間隙拡大部の境界部付近に位置し、回転スリーブ体の回転時には、界面引込機構により基端界面が基端側ラジアル軸受部の側に引き込まれ、前記外部開口は外気に開口する。

【００４０】先端側ラジアル軸受部又は基端側ラジアル軸受部に保持された潤滑液が、通気孔内面を経て通気孔の外部開口へ滲み出ようとすることがあった場合、回転スリーブ体の回転時には界面引込機構により基端側ラジアル軸受部の側に引き込まれ、非回転時には、通気孔の外部開口が潤滑液中に開口するので、何れにせよ潤滑液が更に外部へ滲出することが防がれる。

(3-2)　(3) 又は(3-1) の動圧流体軸受装置は、軸部の外周面における先端側ラジアル軸受部の基端側と第１間隙拡大部との境界部付近に、径方向外方開口の周方向の基端側円弧状溝部を有し、その基端側円弧状溝部と外部とを、少なくとも回転スリーブ体の回転時に連通する通気孔を、前記固定軸体内に備えるものとすることが好ましい（請求項４）。

【００４１】この通気孔は(3) の通気孔と共用部分を有するものであってよい。通気孔の好ましい横断面サイズは(3) に記された通りである。

【００４２】軸部の外周面における先端側ラジアル軸受部の基端側と第１間隙拡大部との境界部付近に有する周方向の基端側円弧状溝部と外部とが、少なくとも回転スリーブ体の回転時に通気孔により連通する。そのため、回転スリーブ体の回転時に、先端側ラジアル軸受部において、公差、組立、熱変形等の要因により、先端向きに潤滑液が移動する圧力が発生し、その潤滑液が先端向きに移動する場合に、通気孔及び基端側円弧状溝部を通じて先端側ラジアル軸受部内に基端側から気体が導入される。この気体は、潤滑液の移動量が比較的に小さい段階で先端側ラジアル軸受部内部に導入され、それにより先端向きの潤滑液移動圧力が減少してバランスするようになるので、潤滑液の先端側への移動量が比較的に小さく抑えられる。

(4)　(1)、(1-1)、(2)、(3) 又は(3-1) の動圧流体軸受装置は、スラスト部に外嵌する径方向内方開口の環状のスラスト溝部を回転スリーブ体が有し、そのスラスト溝部の基端側の面及び先端側の面をそれぞれ回転スラスト面とし、スラスト部の先端側の面と先端側の回転スラスト面が相対する部分と、スラスト部の基端側の面と基端側の回転スラスト面が相対する部分の両方にスラスト軸受部を有し、先端側スラスト軸受部と基端側スラスト軸受部の潤滑液は、スラスト部の外周端面とスラスト溝部の外周部の間の部分を介して連続し、先端側及び基端側の各スラスト軸受部に、各スラスト軸受部における潤滑液が回転スリーブ体の回転に伴い内周側から外周側へ移動する圧力分布を生じさせる動圧発生機構を有し、先端側スラスト軸受部の径方向内方に潤滑液の先端界面を有し、スラスト部の外周端面、並びにスラスト部の先端側の面及び基端側の面のうち先端側及び基端側のスラスト軸受部の内周側の部分において、それぞれスラスト溝部とスラスト部の間隙に充填された潤滑液内に開口する潤滑液循環路をスラスト部内に有するものとすることができる（請求項５）。

【００４３】上記動圧発生機構は、先端側及び基端側のスラスト軸受部にそれぞれ動圧発生溝部を設け、回転スリーブ体の回転に伴いその動圧発生溝部によって潤滑液に発生する動圧が、その先端側及び基端側のスラスト軸受部における外周側に偏って高くなるものとすることができる。そのためには、例えば動圧発生溝部の動圧発生溝としてヘリングボーン溝を用いた場合、その動圧発生溝部の中心をスラスト軸受部における外周側に偏心させた構造を採用し得る。また動圧発生溝部は、スラスト部及びスラスト溝部の何れか又は両方に設けることができる。

【００４４】回転スリーブ体が回転すると、各スラスト軸受部における潤滑液は、内周側から外周側へ移動し、次いで、スラスト部の外周端面からスラスト部内の潤滑液循環路を経て、スラスト部の先端側の面及び基端側の面のうち先端側及び基端側のスラスト軸受部の内周側の部分に流れて循環する。このように潤滑液が循環することにより、スラスト溝部とスラスト部の間隙に充填された潤滑液内の気泡、特にスラスト軸受部の外周側の気泡が、先端側スラスト軸受部の径方向内方に位置する潤滑液の界面から外気に解放される。

【００４５】潤滑液循環路は、１又は２以上とすることができる。

【００４６】スラスト部の外周端面には、径方向外方開口の周方向の導入溝部を有し、潤滑液循環路の開口部がその導入溝部内に位置するものとすることが好ましい。

潤滑液が気泡を伴って潤滑液循環路の開口部に導入されやすくするためである。導入溝部は、全周にわたるものとすることができるが、周方向に部分的に有するものであってもよい。

(5)　本発明の電動機は、上記(1)、(2)、(3)、(3-1) 又は(4) の動圧流体軸受装置を備え、回転スリーブ体がロータとして回転するものである（請求項６）。

【００４７】この電動機は、電動機は、ハードディスク等の磁気ディスク、光磁気ディスク、ＣＤ－ＲＯＭ、ＣＤ－Ｒ、ＣＤ－ＲＷ、ＤＶＤ等の光ディスクを始めとする記録媒体、特に円盤状記録媒体を駆動するためのスピンドルモータの他、種々の電動機として用いることができる。

【００４８】

【発明の実施の形態】本発明の実施の形態を、図１乃至図３を参照しつつ説明する。

【００４９】図１は、本発明の実施の形態の一例としての、動圧流体軸受装置を備えたハードディスク駆動用のスピンドルモータ（電動機）の断面図、図２は、そのスピンドルモータの動圧流体軸受装置における回転スラスト板の下方斜視図、図３は、図１における回転スラスト板の右側部付近の拡大図である。但し、図１における回転スラスト板及びその周辺部は、図２におけるＩ－Ｏ－Ｉ線に対応する。

【００５０】スピンドルモータの基盤１０の嵌合孔に固定軸体１２の下端部（基端部）が嵌合固定されることにより、固定軸体１２が立設固定されている。基盤１０の上側における固定軸体１２の外周側には、ステータコイル１４が巻回されたステータコア１６を保持する保持体１３が固定されている。

【００５１】固定軸体１２は、上下方向の固定軸部材１２ａ（軸部）と、その固定軸部材１２ａの上部に同軸状に外嵌固定された環状板状の固定スラスト板１２ｂ（スラスト板部）とを有してなる。固定軸体１２には、ロータハブ１８ａと回転スラスト板１８ｂからなる回転スリーブ体１８が外嵌されている。

【００５２】ロータハブ１８ａの円筒面状の外周部にハードディスクが外嵌保持される。ロータハブ１８ａのほぼ下半部は、内周側のスリーブ部１８ａ１と外周側のロータマグネット保持部１８ａ２の二重管状をなす。スリーブ部１８ａ１は、固定軸部材１２ａのうち固定スラスト板１２ｂと基盤１０との間の部分にスリーブ嵌合している。スリーブ部１８ａ１の上方の内径は、上方（先端側）に向かって、中内径部１８ａ３及び大内径部１８ａ４へと順次拡径されている。この大内径部１８ａ４の下端部に回転スラスト板１８ｂが内嵌固定されることにより、中内径部１８ａ３の内周側に径方向内方開口の環状のスラスト溝部２０が形成され、このスラスト溝部２０が固定スラスト板１２ｂに外嵌している。大内径部１８ａ４における回転スラスト板１８ｂの上側には、環状板状のシール部材２２が内嵌固定されている。

【００５３】固定軸体１２は、下端部を基盤１０に、固定軸部材１２ａの上端部をハードディスク駆動装置の蓋体（図示せず）等に固定することができるので、回転スリーブ体１８の安定的な回転を実現することができる。

【００５４】ロータハブ１８ａのロータマグネット保持部１８ａ２には、強磁性材料製の円筒状ロータヨーク２４が内嵌固定され、その円筒状ロータヨーク２４に円筒状のロータマグネット２６が内嵌固定され、ステータコア１６と径方向空隙を隔てて相対している。ロータは、回転スリーブ体１８と円筒状ロータヨーク２４とロータマグネット２６からなる。

【００５５】固定軸部材１２ａの外周部のうちスリーブ部１８ａ１の下端部に相対する部分は、下方に向かってテーパ状に縮径し、これにより、スリーブ部１８ａ１の内周面との間の間隙が下方に向かって漸次拡大する下端（基端）径方向間隙拡大部２８が形成されている。スリーブ部１８ａ１の内周面の下端部には撥油剤の塗布等の撥油処理が施されている。

【００５６】スラスト溝部２０の上側面の下側内周側部は、内方に向かって上向きに傾斜し、固定スラスト板１２ｂの上面との間に、漸次間隙が拡大する上側（先端側）軸心方向間隙拡大部２９が形成されている。上側軸心方向間隙拡大部２９の内周側には、固定軸部材１２ａの外周面及びそれに相対する回転スラスト板１８ｂの内周面の環状凹部によって更に軸心方向及び径方向に間隙が拡大された環状空間部３１が形成されている。その環状空間部３１の上方において回転スラスト板１８ｂの内周面及びそれと径方向の比較的狭い空隙を隔てて相対する固定軸部材１２ａの外周面には、撥油剤の塗布等の撥油処理が施されている。

【００５７】また、シール部材２２と回転スラスト板１８ｂの間に径方向内方開口の環状の潤滑油捕捉溝３０が形成され、シール部材２２の内周面及びそれと径方向の比較的狭い空隙（例えば５０μｍ）を隔てて相対する固定軸部材１２ａの外周面には、撥油剤の塗布等の撥油処理が施されている。

【００５８】固定スラスト板１２ｂの下側内周側部１２ｂ１は、内方に向かって上向きに傾斜し、スラスト溝部２０の下側面との間に、漸次間隙が拡大する下側（基端側）軸心方向間隙拡大部３２が形成されている。

【００５９】固定スラスト板１２ｂの下側内周側部１２ｂ１における１８０度中心角を隔てた２箇所に、それぞれ径方向の連絡突条部３４を有する。連絡突条部３４の下面は、固定スラスト板１２ｂの下側外周側部１２ｂ２と平行であり、周方向の両側面は上方に向かってやや拡開する。連絡突条部３４の内端面は、下側内周側部１２ｂ１の内周縁から下方に向かって径方向外方に傾斜することにより、固定軸部材１２ａの外周面との間に、径方向間隙が下方に向かって漸次拡大して楔形状をなすスリ

ット部３６を有する。連絡突条部３４とスラスト溝部２０の下側面との間に、径方向の連絡路３７が形成されている。

【００６０】固定スラスト板１２ｂの上面及び下面に、それぞれ動圧発生用のヘリングボーン溝部３８（ヘリングボーン溝以外の動圧発生用溝を用いることもできる。）が設けられ、それぞれスラスト溝部２０の上側面（回転スラスト板１８ｂの下面）及びスラスト溝部２０の下側面との間に上（先端側）スラスト軸受部４０及び下（基端側）スラスト軸受部４２が構成されている。

【００６１】固定軸体１２と回転スリーブ体１８との間隙の必要箇所に潤滑油４４が充填されている。スラスト溝部２０と固定スラスト板１２ｂの間隙に充填された潤滑油４４の上側界面及び下側界面は、それぞれ上側軸心方向間隙拡大部２９及び下側軸心方向間隙拡大部３２において径方向内方を向く。下側軸心方向間隙拡大部３２は、内方に向かって漸次間隙が拡大するので、下側軸心方向間隙拡大部３２に位置する潤滑油４４が表面張力により径方向外方すなわち下スラスト軸受部４２側へ確実性高く引き寄せられ、下側軸心方向間隙拡大部３２において潤滑油４４が下スラスト軸受部４２と内周側とに分離することが防がれる。

【００６２】下側軸心方向間隙拡大部３２の内周部のうち連絡路３７以外の部分は気体部分４６である。連絡路３７、すなわち連絡突条部３４とスラスト溝部２０の下側面との間には、潤滑油４４が表面張力により保持され、これによって、固定軸部材１２ａとスリーブ部１８ａ１との間隙に保持された潤滑油４４の上端部と、下スラスト軸受部４２に保持された潤滑油４４の内周部が連続する。

【００６３】ヘリングボーン溝部３８は、その動圧の中心が上スラスト軸受部４０及び下スラスト軸受部４２における外周側に偏心するように設けられ、上下スラスト軸受部４０・４２における潤滑油４４が回転スリーブ体１８の回転に伴い内周側から外周側へ移動する圧力分布を生じる。

【００６４】固定スラスト板１２ｂの内周面における連絡突条部３４と９０度中心角を隔てた２箇所に、固定軸部材１２ａの外周面との間に呼吸孔４８を形成する軸心方向溝４８ａを有する。呼吸孔４８は、気体部分４６と外部とを、環状空間部３１並びに固定軸部材１２ａの外周面と回転スラスト板１８ｂの内周面及びシール部材２２の内周面との間隙を介して連通する。

【００６５】固定スラスト板１２ｂの外周端面、並びに固定スラスト板１２ｂの上側の面及び下側の面のうち上下スラスト軸受部４０・４２の内周側の部分において、それぞれスラスト溝部２０と固定スラスト板１２ｂの間隙に充填された潤滑油４４内に開口する潤滑油循環路５０を固定スラスト板１２ｂ内に有する。固定スラスト板１２ｂの外周端面には、全周にわたる径方向外方開口の断面弓形状の導入溝部５２を有し、潤滑油循環路５０の開口部がその導入溝部５２内に位置する。

【００６６】回転スリーブ体１８が回転すると、上下スラスト軸受部４０・４２における潤滑油４４は、内周側から外周側へ移動し、次いで、固定スラスト板１２ｂの外周端面から固定スラスト板１２ｂ内の潤滑油循環路５０を経て、固定スラスト板１２ｂの上側の面及び下側の面のうち上下スラスト軸受部４０・４２の内周側の部分に流れて循環する。このように潤滑油４４が循環することにより、スラスト溝部２０と固定スラスト板１２ｂの間隙に充填された潤滑油４４内の気泡、特に上下スラスト軸受部４０・４２の外周側の気泡が、上スラスト軸受部４０の径方向内方に位置する潤滑油４４の界面から外気に解放される。

【００６７】スリーブ部１８ａ１の内周面の上部及び下部には、それぞれ動圧発生用のヘリングボーン溝部５４・５５（ヘリングボーン溝以外の動圧発生用溝を用いることもできる。）が設けられ、固定軸部材１２ａの外周面との間でそれぞれ上ラジアル軸受部５６及び下ラジアル軸受部５８が構成されている。そのうち下ラジアル軸受部５８の動圧発生用のヘリングボーン溝部５５は、下端径方向間隙拡大部２８の上部に達しており、回転スリーブ体１８の回転に伴いそのヘリングボーン溝部５５により潤滑油４４に発生する動圧の軸心方向における中心が、その下ラジアル軸受部５８の軸心方向における中心よりも上寄りになるよう設けられている。スリーブ部１８ａ１の内周面と固定軸部材１２ａの外周面との間隙は、上下ラジアル軸受部５６・５８において通常数μｍである。

【００６８】固定軸部材１２ａにおけるスリーブ部１８ａ１に相対する部分の上端部のうち、呼吸孔４８を中心とした周方向の４分の１円周部分（連絡路３７が存在しない周方向部分）に、断面略Ｖ字形状に径方向外方に開口する周方向の上側円弧状溝部５９を有する。上側円弧状溝部５９は、環状凹部６０の深さよりも浅く形成されている。

【００６９】固定軸部材１２ａは、その外周面における上下ラジアル軸受部５６・５８の間に、径方向外方開口の断面弓形状の環状凹部６０を有する。その環状凹部６０と固定軸部材１２ａの外周面との間に、中間径方向間隙拡大部６２が形成される。中間径方向間隙拡大部６２は、上ラジアル軸受部５６から下方に向かって漸次径方向間隙が拡大する上間隙拡大部（第１間隙拡大部）がその上半部を構成し、下ラジアル軸受部５８から上方に向かって漸次径方向間隙が拡大する下間隙拡大部（第２間隙拡大部）が下半部を構成する。

【００７０】この上間隙拡大部に、上ラジアル軸受部５６に保持された潤滑油４４の下端側の界面を有し、下間隙拡大部に、下ラジアル軸受部５８に保持された潤滑油４４の上端側の界面を有する。

【００７１】上側円弧状溝部５９とスリーブ部１８ａ１の内周面との間に形成される周方向の円弧状径方向間隙拡大部に、上ラジアル軸受部５６に保持された潤滑油４４のうち上側円弧状溝部５９に対応する周方向部分の上端側界面が、表面張力により位置し、その周方向部分において、上ラジアル軸受部５６に保持された潤滑油４４が下側軸心方向間隙拡大部３２に流入することが防がれる。

【００７２】また、下ラジアル軸受部５８に保持された潤滑油４４の下端側界面は、下端径方向間隙拡大部２８に位置する。

【００７３】固定軸部材１２ａの外周面における上ラジアル軸受部５６の下端側と中間径方向間隙拡大部６２の上間隙拡大部との境界部付近に、断面略Ｖ字形状に径方向外方に開口する４分の１円周にわたる周方向の下側円弧状溝部６３を有する。下側円弧状溝部６３は、環状凹部６０の深さよりも浅く形成されている。

【００７４】固定軸部材１２ａ内に、外部開口６４ａが下ラジアル軸受部５８と下端径方向間隙拡大部２８の境界部付近に位置する通気孔６４を有する。通気孔６４の第１内部開口６４ｂは、中間径方向間隙拡大部６２における上間隙拡大部と下間隙拡大部の中間部付近に開口する。通気孔６４の第２内部開口６４ｃは、下側円弧状溝部６３に開口する。

【００７５】回転スリーブ体１８の回転時には、下ラジアル軸受部５８に保持された潤滑油４４の下端側界面は、下ラジアル軸受部５８のヘリングボーン溝部５５により、下端径方向間隙拡大部２８の上部又は更に上方に引き込まれ、通気孔６４の外部開口６４ａは外気に開口する。

【００７６】中間径方向間隙拡大部６２における上間隙拡大部及び下間隙拡大部には潤滑油４４が貯留される。上ラジアル軸受部５６又は下ラジアル軸受部５８において、蒸発や衝撃による脱落等により潤滑油４４が減少した場合に、中間径方向間隙拡大部６２の上間隙拡大部に貯留された潤滑油４４は先端側ラジアル軸受部に、中間径方向間隙拡大部６２の下間隙拡大部に貯留された潤滑油４４は基端側ラジアル軸受部に、それぞれ補給される。潤滑油４４の補給に伴い、通気孔６４を通じて中間径方向間隙拡大部６２に外気が導入される。

【００７７】下スラスト軸受部４２に保持された潤滑油４４の内周部と、固定軸部材１２ａとスリーブ部１８ａ１の間隙に保持された潤滑油４４の先端部との間が、連絡路３７に保持された潤滑油４４により連続する。下スラスト軸受部４２と上ラジアル軸受部５６の何れかにおいて蒸発や衝撃による脱落等により潤滑油４４が減少した場合、潤滑油４４が減少した軸受部に対し他方の軸受部から、連絡路３７を介して潤滑油４４が補給される。そのため、一方の軸受部のみについて潤滑油不足が生じて装置が短寿命化するという不都合の発生が防がれる。

【００７８】上ラジアル軸受部５６は、公差範囲程度でやや上方寄りに潤滑油４４の動圧が高くなるアンバランスを生じするよう設計されている。

【００７９】回転スリーブ体１８の回転時に、公差、組立、熱変形等の要因により、上ラジアル軸受部５６に保持されて上端側が下側軸心方向間隙拡大部３２に臨む潤滑油４４に下向きに移動する圧力が発生し、その潤滑油４４が下向きに移動することがあり得る。その場合、下向き移動圧力が限度を超えると、連絡路３７における潤滑油４４に対する遠心力や表面張力等とも作用し合って、下スラスト軸受部４２に保持された潤滑油４４の内周部と、固定軸部材１２ａとスリーブ部１８ａ１の間隙に保持された潤滑油４４の先端部との間の、連絡路３７による潤滑油４４の連続が途切れることとなる。スリット部３６は、このような潤滑油４４の連続の途切れを開始し易くするものである。

【００８０】連絡路３７による潤滑油４４の連続が途切れることにより、下スラスト軸受部４２に保持された潤滑油４４が上ラジアル軸受部５６へ過剰に移動して下スラスト軸受部４２を潤滑する潤滑油４４の量が過少になることが確実性高く防がれる。また、このように潤滑油４４が途切れて上端側から上ラジアル軸受部５６に空気等の気体が導入されれば、それにより下向きの潤滑油移動圧力が減少してバランスするようになるので、潤滑油４４の下側への移動が抑えられる。この際、上側円弧状溝部５９を通じて上端側から上ラジアル軸受部５６に気体が導入され易いので、潤滑油４４の下方への移動がより確実に抑えられる。

【００８１】前記のような固定軸部材１２ａとスリーブ部１８ａ１の間隙に保持された潤滑油４４に対する下向き移動圧力が回転中に又は回転停止により解消されれば、下スラスト軸受部４２に保持された潤滑油４４の内周部と、固定軸部材１２ａとスリーブ部１８ａ１の間隙に保持された潤滑油４４の先端部との間の、連絡路３７による潤滑油４４の連続が回復し得る。

【００８２】なお、下側軸心方向間隙拡大部３２の気体部分の拡大又は縮小に伴い、呼吸孔４８を通じて空気等の気体の移動が生じる。

【００８３】また、回転スリーブ体１８の回転時に、上ラジアル軸受部５６において、公差、組立、熱変形等の要因により、上向きに潤滑油４４が移動する圧力が発生し、その潤滑油４４が上向きに移動する場合に、通気孔６４及び下側円弧状溝部６３を通じて上ラジアル軸受部５６内に下端側から気体が導入される。この気体は、潤滑油４４の上方移動量が比較的に小さい段階で上ラジアル軸受部５６内部に導入され、それにより上向きの潤滑油移動圧力が減少してバランスするようになるので、潤滑油４４の上方への移動量が比較的に小さく抑えられる。

【００８４】更に、回転スリーブ体１８が回転すると、

固定軸体１２と回転スリーブ体１８の間隙に充填された潤滑油４４に遠心力が作用する。そのため、非回転時においては下端径方向間隙拡大部２８に下端界面が位置するように表面張力により保持されていた潤滑油４４が、遠心力の作用によって更に下方へ滲出若しくは漏出することにより、或いは衝撃により脱落することにより散逸し易い状態となるが、下ラジアル軸受部５８に保持された潤滑油４４の下端側界面は、下ラジアル軸受部５８のヘリングボーン溝部５５により、下端径方向間隙拡大部２８の上部又は更に上方に引き込まれるので、遠心力の作用による潤滑油４４の滲出又は漏出による散逸、或いは衝撃により脱落することによる散逸が生じ難くなる。

【００８５】なお、以上の実施の形態についての記述における上下位置関係は、単に図に基づいた説明の便宜のためのものであって、実際の使用状態等を限定するものではない。

【００８６】

【発明の効果】本発明の動圧流体軸受装置及び電動機によれば、基端側スラスト軸受部及びラジアル軸受部の一方のみについて潤滑液不足が生じて装置が短寿命化するという不都合の発生が防がれると共に、基端側スラスト軸受部に保持された潤滑液がラジアル軸受部へ過剰に移動して基端側スラスト軸受部を潤滑する潤滑液の量が過少になることが防がれる。

【００８７】請求項４の動圧流体軸受装置及びそれを備えた電動機によれば、先端側ラジアル軸受部の潤滑液の先端側への移動量が比較的に小さく抑えられる。

【００８８】請求項５の動圧流体軸受装置及びそれを備えた電動機によれば、スラスト溝部とスラスト部の間隙に充填された潤滑液内の気泡が外気に解放される。

【図面の簡単な説明】

【図１】ハードディスク駆動用のスピンドルモータについての断面図である。

【図２】回転スラスト板の下方斜視図である。

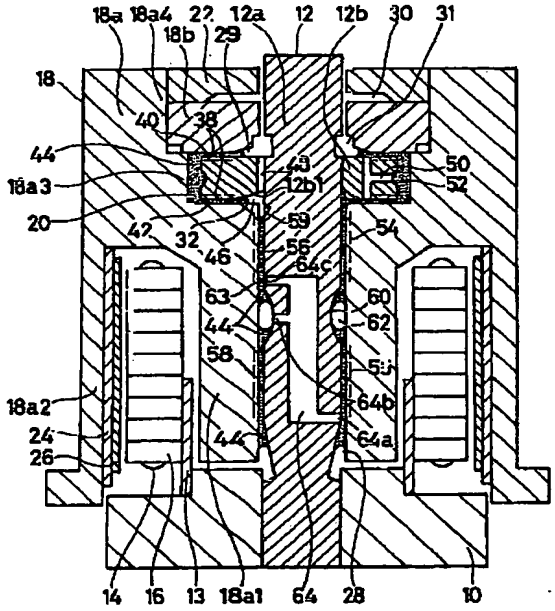
【図３】図１における回転スラスト板の右側部付近の拡大図である。

【図４】ハードディスク駆動用のスピンドルモータの従来例についての断面図である。

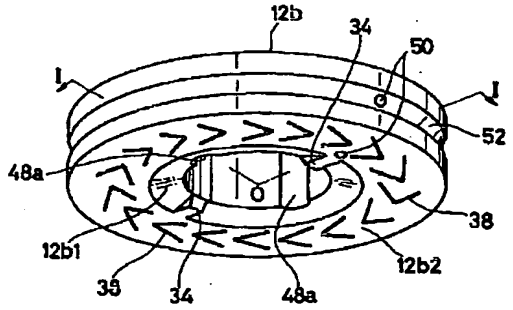
【符号の説明】

１２ａ	固定軸部材
１２ｂ	固定スラスト板
１２ｂ１	下側内周側部
１８ａ１	スリーブ部
２０	スラスト溝部
３４	連絡突条部
３６	スリット部
３７	連絡路
４２	下スラスト軸受部
４４	潤滑油

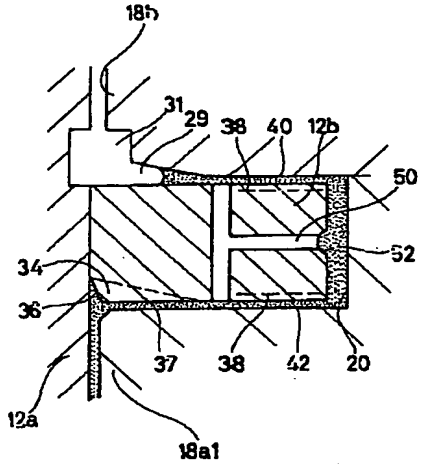
【図１】



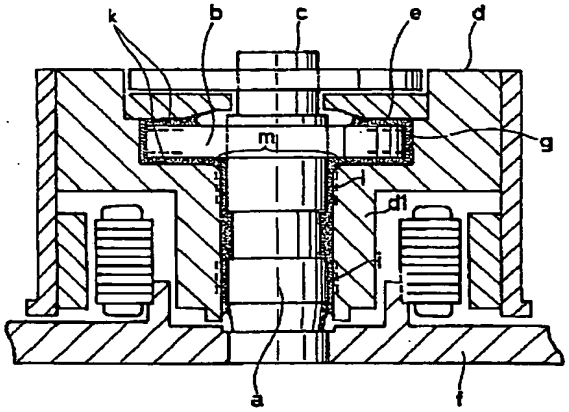
【図２】



【図3】


18b
31
29
38
40
12b
50
52
34
36
37
38
42
20
12a
18a1

【図4】


k
b
c
e
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m
g
l
d1
i
a
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Bibliography

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Epitome

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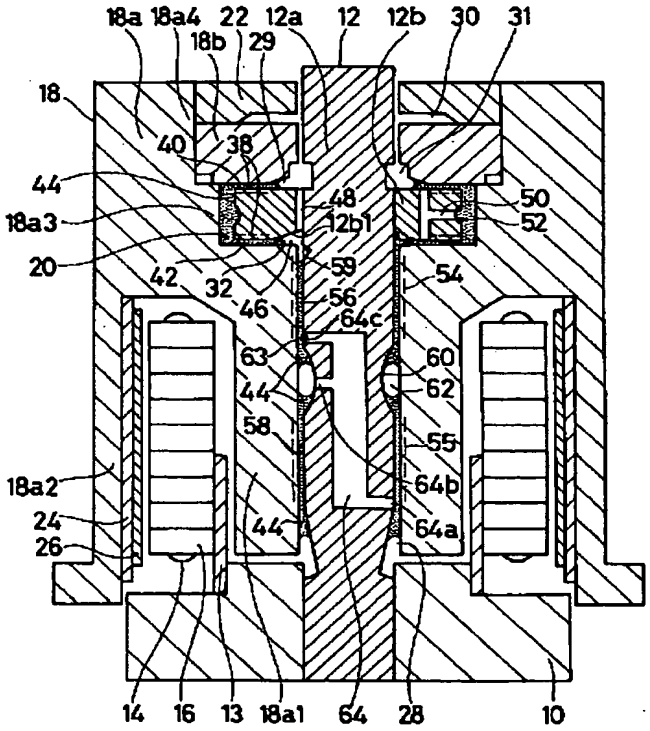
(57) [Abstract]
[Technical problem] It prevents the lack of a lubricant arising in either the thrust-bearing section or the radial bearing section, and equipment forming a short life. It prevents the amount of the lubricant with which the lubricant held at the thrust-bearing section moves to the radial bearing section superfluously, and carries out the lubrication of the thrust-bearing section at the time of rotation of a rotation sleeve object becoming [too little].
[Means for Solution] The communication protruding line section 34 of the direction of a path is formed in two in the bottom inner circumference flank 12b1 of fixed thrust plate 12b which separated the central angle 180 degrees. It has the slit section 36 between the inner end face of the communication protruding line section 34, and the peripheral face of fixed shank material 12a. It has the communication way 37 of the direction of a path between the bottom sides of the communication protruding line section 34 and the thrust slot 20. The inner circumference section of the lubricating oil 44 held at the upper limit section of the lubricating oil 44 which the lubricating oil 44 was held with surface tension on the communication way 37, and was held in the gap of fixed shank material 12a and the sleeve section 18a1, and the bottom thrust bearing section 42 continues.

[Translation done.]



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CLAIMS

[Claim(s)]
[Claim 1] The sleeve section which carried out sleeve fitting from a shank and its shank among [thrust section] said shanks at the part by the side of a end face to the fixed axis which comes to have the thrust section jutted out to the method of the outside of the direction of a path, The rotation sleeve object which comes to have the rotation thrust side which faces the direction end face side of an axial center in the field by the side of the end face of said thrust section In the thrust bearing section which the radial bearing section which a shank and the sleeve section mainly face, and a rotation thrust side and a thrust section face through the lubricant with which the gap of said fixed axis and a rotation sleeve object was filled up To the inner circumference side of the end face side thrust bearing section which is dynamic pressure liquid bearing equipment which it comes to support free [rotation], and it has into the part which the field and rotation thrust side by the side of the end face of said thrust section face It has the direction gap limb of a end face side shaft alignment with the larger direction gap of an axial center of the field by the side of the end face of a thrust section, and a rotation thrust side than said end face side thrust bearing section. The inner circumference section of the lubricant with which the lubricant with which the direction gap of an axial center was narrow with the lubricant to extent with which a lubricant may be held with surface tension, and was held at a part of the direction gap limb of a end face side shaft alignment at it was held at the end face side thrust bearing section, It has the communication way which may continue between a shank and the point of the lubricant held in the gap of the sleeve section. The inner circumference section is a gas part at least among parts other than said communication way of said direction gap limb of a end face side shaft alignment. Dynamic pressure liquid bearing equipment characterized by continuation of the lubricant by the communication way breaking off when the lubricant which it has the spiracle which opens the gas part and exterior for free passage in a fixed axis, it is held at the radial bearing section, and a tip side faces the direction gap limb of a end face side shaft alignment moves to the end face sense.
[Claim 2] Dynamic pressure liquid bearing equipment according to claim 1 with which the interface of the method of the inside of the direction of a path of the lubricant with which the direction gap of an axial center is gradually expanded, and the direction gap limb of a end face side shaft alignment was held in the end face side thrust bearing section toward the method of the inside of the direction of a path at this direction gap limb of a end face side shaft alignment is located.
[Claim 3] Dynamic pressure liquid bearing equipment according to claim 1 or 2 which has the height which continues in the direction of a path mostly and the slit section which is formed between rotation thrust sides, carries out opening to both hoop direction and the direction end face sense of an axial center in the direction toe of a path of the height, and can hold a lubricant with surface tension from which the above-mentioned communication way is established in the field by the side of the end face of a thrust section, and projects in the end face sense.
[Claim 4] The tip side radial bearing section to which the tip side approached the gap of the field by the side of the end face of a thrust section, and a rotation thrust side as the radial bearing section, It has the end face side radial bearing section located in a end face side rather than the tip side radial bearing section. Between said tip side radial bearing section and the end face side radial bearing section It has the direction gap limb of the diameter of middle with the larger direction gap of a path of the peripheral face of a shank, and the inner skin of the sleeve section than both the radial bearing section. The direction gap limb of the diameter of middle The 1st gap limb which the direction gap of a path expands gradually toward a end face side from said tip side radial bearing section, While having the 2nd gap limb which the direction gap of a path expands gradually toward a tip side from said end face side radial bearing section and having an interface by the side of the end face of the lubricant held at the tip side radial bearing section in said 1st gap limb It has an interface by the side of the tip of the lubricant held at the end face side radial bearing section in said 2nd gap limb. Near pars intermedia and the exterior of the 1st gap limb and the 2nd gap limb in the direction gap limb of the diameter of middle It has

the air hole which is open for free passage at least at the time of rotation of a rotation sleeve object in said fixed axis. Near the boundary section with the 1st gap limb, the end face side of the tip side radial bearing section in the peripheral face of a shank Dynamic pressure liquid bearing equipment according to claim 1, 2, or 3 equipped with the air hole which has the end face side circular slot of the hoop direction of method opening of the outside of the direction of a path, and opens the end face side circular slot and exterior for free passage at least at the time of rotation of a rotation sleeve object in said fixed axis.
[Claim 5] A rotation sleeve object has the annular thrust slot of method opening of the inside of the direction of a path attached outside a thrust section. The part which the field by the side of the end face of the thrust slot and the field by the side of a tip are made into a rotation thrust side, respectively, and the field by the side of the tip of a thrust section and the rotation thrust side by the side of a tip face, It has the thrust bearing section into both parts which the field by the side of the end face of a thrust section and the rotation thrust side by the side of a end face face. The lubricant of the tip side thrust bearing section and the end face side thrust bearing section It continues through the part between the periphery end face of a thrust section, and the periphery section of a thrust slot. It has the dynamic pressure developmental mechanics which produces the pressure distribution which the lubricant in each thrust-bearing section moves to each thrust-bearing section by the side of a tip and a end face from an inner circumference side with rotation of a rotation sleeve object to a periphery side. Have the tip interface of a lubricant in the method of the inside of the direction of a path of the tip side thrust bearing section, and it sets at the periphery end face of a thrust section, and a list into the part by the side of the inner circumference of the thrust bearing section by the side of a tip and a end face among the field by the side of the tip of a thrust section, and the field by the side of a end face. Dynamic pressure liquid bearing equipment according to claim 1, 2, 3, or 4 which has the lubricant circuit which carries out opening into the lubricant with which the gap of a thrust slot and a thrust section was filled up, respectively in thrust circles.
[Claim 6] The motor which is equipped with dynamic pressure liquid bearing equipment according to claim 1, 2, 3, 4, or 5, and a rotation sleeve object rotates as Rota.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] The motor equipped with the dynamic pressure liquid bearing equipment with which it comes to support a rotation sleeve object free [rotation] through a lubricant to the fixed axis which comes to have the thrust section which jutted this invention out of the shank, and its dynamic pressure liquid bearing equipment, While inconvenient generating that the lack of a lubricant arises about either the thrust-bearing section or the radial bearing section, and equipment forms a short life especially is prevented It is related with the motor equipped with the dynamic pressure liquid bearing equipment prevented and its dynamic pressure liquid bearing equipment that the amount of the lubricant which the lubricant held at the thrust-bearing section moves to the radial bearing section superfluously, and carries out the lubrication of the thrust-bearing section becomes [too little].
[0002]
[Description of the Prior Art] Drawing 4 is a sectional view about the conventional example of the spindle motor (motor) equipped with the dynamic pressure liquid bearing equipment with which the rotation sleeve object d as

Rota was supported free [rotation] through the lubricating oil e (lubricant) to the fixed axis c of the vertical direction which has thrust Itabe b who jutted out of Shank a for a hard disk drive.

[0003] The lower limit section (end face section) is being fixed to Base f, and the upper limit section (point) is fixed to the lid of hard disk drive etc. for the fixed axis c. Among the shanks a of the fixed axis c, from thrust Itabe b, the sleeve section d1 of the rotation sleeve object d carries out sleeve fitting at the part by the side of a end face, and opening of the annular thrust slot g is carried out to the method of the inside of the direction of a path, and it is attaching it outside thrust Itabe b.

[0004] In the spindle motor equipped with such conventional dynamic pressure liquid bearing equipment The lubricating oil e of the thrust bearing section k formed in the gap of thrust Itabe b and the thrust slot g When the lubricating oil e of the radial bearing section i formed in the gap of the sleeve section d1 and Shank a is continuing, at the time of rotation of the rotation sleeve object d according to factors, such as tolerance, assembly, and heat deformation If the lubricating oil e of the radial bearing section i moves downward (end face sense), since both the lubricating oils e of the thrust bearing section k which follows it will move If movement magnitude becomes large, the lubricating oils e of the thrust bearing section k will run short, and un-arranging [that rotation precision falls or bearing equipment, i.e., a spindle motor, forms a short life] occurs.

[0005] On the other hand, it has the annular gas part m in the inner circumference section among the gaps of the field by the side of thrust Itabe's b end face, and the field by the side of the end face of the thrust slot g. If lubricating oils e decrease in number according to evaporation, omission by the impact, etc. to one of bearings when the lubricating oil e of the thrust-bearing section k and the lubricating oil e of the radial bearing section i have dissociated Un-arranging [that rotation precision falls with the lack of a lubricating oil produced in bearing of one of these, or the whole whole bearing equipment, i.e., a spindle motor, forms a short life] occurs.

[0006] Moreover, at the time of rotation of the rotation sleeve object d, according to factors, such as tolerance, assembly, and heat deformation, when the lubricating oil e of the radial bearing section i moves upward (tip sense) too much, that the lubricating oils e of the radial bearing section i run short may arise.

[0007] Furthermore, at the time of rotation of the rotation sleeve object d, air bubbles tend to collect near the periphery section of the gap of the thrust slot g and thrust Itabe b, and, as for the air bubbles, ** is also hard to be released outside. Such air bubbles also become the cause of expanding with heat and making a lubricating oil e leaking to the exterior.

[0008] This invention is performed in view of the above troubles which consisted in the conventional technique. The 1st purpose While inconvenient generating that the lack of a lubricant arises about either the thrust-bearing section or the radial bearing section, and equipment forms a short life is prevented It is that the amount of the lubricant with which the lubricant held at the thrust-bearing section moves to the radial bearing section superfluously, and carries out the lubrication of the thrust-bearing section at the time of rotation of a rotation sleeve object becomes [too little] to offer the dynamic pressure liquid bearing equipment and the motor which are prevented.

[0009] Moreover, the movement magnitude by the side of the tip of the lubricant of the radial bearing section by the lubricant migration pressure of the tip sense at the time of rotation of a rotation sleeve object is stopped, and the 2nd purpose is to offer the dynamic pressure liquid bearing equipment and the motor with which the lack of a lubricant of the radial bearing section is prevented.

[0010] Furthermore, the 3rd purpose is to offer the dynamic pressure liquid bearing equipment and the motor which can release the air bubbles near the periphery section of the gap of a thrust slot and thrust Itabe to the exterior.

[0011]

[Means for Solving the Problem] (1) The sleeve section in which the dynamic pressure liquid bearing equipment of this invention carried out sleeve fitting from a shank and its shank among [thrust section] said shanks at the part by the side of a end face to the fixed axis which comes to have the thrust section jutted out to the method of the outside of the direction of a path, The rotation sleeve object which comes to have the rotation thrust side which faces the direction end face side of an axial center in the field by the side of the end face of said thrust section In the thrust bearing section which the radial bearing section which a shank and the sleeve section mainly face, and a rotation thrust side and a thrust section face through the lubricant with which the gap of said fixed axis and a rotation sleeve object was filled up To the inner circumference side of the end face side thrust bearing section which is dynamic pressure liquid bearing equipment which it comes to support free [rotation], and it has into the part which the field and rotation thrust side by the side of the end face of said thrust section face It has the direction gap limb of a end face side shaft alignment with the larger direction gap of an axial

center of the field by the side of the end face of a thrust section, and a rotation thrust side than said end face side thrust bearing section. The inner circumference section of the lubricant with which the lubricant with which the direction gap of an axial center was narrow with the lubricant to extent with which a lubricant may be held with surface tension, and was held at a part of the direction gap limb of a end face side shaft alignment at it was held at the end face side thrust bearing section, It has the communication way which may continue between a shank and the point of the lubricant held in the gap of the sleeve section. The inner circumference section is a gas part at least among parts other than said communication way of said direction gap limb of a end face side shaft alignment. When the lubricant which it has the spiracle which opens the gas part and exterior for free passage in a fixed axis, it is held at the radial bearing section, and a tip side faces the direction gap limb of a end face side shaft alignment moves to the end face sense, it is characterized by continuation of the lubricant by the communication way breaking off (claim 1).

[0012] The shank and thrust section which constitute a fixed axis may be formed in one, and may come to join the components of another object together.

[0013] In the thrust-bearing section and the radial bearing section, it is desirable to have a slot for dynamic pressure generating, respectively.

[0014] The radial bearing section (when having separated in the tip side radial bearing section and the end face side radial bearing section, it is the tip side radial bearing section) can be designed so that imbalance to which the dynamic pressure of a lubricant becomes high may be produced and made tip approach a little with tolerance-zone extent.

[0015] As a lubricant, various lubricating oils, such as spindle oil, can be used, for example.

[0016] As for the inner circumference section at least, it is desirable that it is [of the direction gap limb of a end face side shaft alignment] large to extent to which the direction gap of an axial center of the field by the side of the end face of a thrust section and a rotation thrust side cannot hold a lubricant for a lubricant with surface tension among both.

[0017] A communication way for example, to a part of direction gap limb of a end face side shaft alignment to one field of the field by the side of the end face of a thrust section, and a rotation thrust side, or both fields It can prepare in the field by the side of the end face of a thrust section preferably by forming the height (for example, almost protruding line section of the direction of a path) which projects in the direction of an axial center and makes the double-sided direction gap of an axial center narrower than other parts of the direction gap limb of a end face side shaft alignment and which continues in the direction of a path mostly. This height can be prepared in one [said] field, between the fields of another side can be made into a communication way, and also the height which faces in the direction of an axial center can be prepared in the field of said both, and between both heights can also be made into a connection way. The number of the communication ways which go to the method of the inside of the direction of a path from the end face side thrust bearing section one, and two or more are sufficient as them.

[0018] Between the inner circumference section of the lubricant held at the end face side thrust-bearing section, and shanks and the points of the lubricant held in the gap of the sleeve section continues with the lubricant held on the communication way. When it sets they to be [any of the end face side thrust-bearing section and the radial bearing section] and lubricants decrease in number according to evaporation, omission by the impact, etc., a lubricant is supplied from bearing of another side through a communication way to bearing to which lubricants decreased in number. Therefore, inconvenient generating that the lack of a lubricant arises only about one bearing, and equipment forms a short life is prevented.

[0019] The pressure which moves to the end face sense occurs in the lubricant which it is held according to factors, such as tolerance, assembly, and heat deformation, in the gap of a shank and the sleeve section at the time of rotation of a rotation sleeve object, and a tip side faces the direction gap limb of a end face side shaft alignment, and the lubricant can move to the end face sense. In that case, when a end face sense migration pressure exceeds a limit, it will act each other with a centrifugal force, surface tension, etc. to a lubricant in a communication way, and continuation of the lubricant by the communication way between the inner circumference section of the lubricant held at the end face side thrust-bearing section, and a shank and the point of the lubricant held in the gap of the sleeve section will break off. It prevents the amount of the lubricant which the lubricant held at the end face side thrust-bearing section moves to the radial bearing section superfluously by that cause, and carries out the lubrication of the end face side thrust-bearing section becoming [too little]. Moreover, if a lubricant breaks off in this way and a gas is introduced into the radial bearing section from a tip side, since the lubricant migration pressure of the end face sense will decrease by that cause and it

will come to balance, the migration by the side of the end face of a lubricant is suppressed.
[0020] while the end face sense migration pressure to the lubricant held in the gap of the above shanks and the sleeve section rotates — or if a rotation halt is solved, continuation of the lubricant by the communication way between the inner circumference section of the lubricant held at the end face side thrust-bearing section, and a shank and the point of the lubricant held in the gap of the sleeve section may be recovered.
[0021] Gaseous migration arises through a spiracle with expansion or contraction of the direction gap limb of a end face side shaft alignment of a gas part.
[0022] As for a spiracle, it is desirable that it shall be the cross-section size to extent prevented with large being held with surface tension (capillarity) in a spiracle after the lubricant has blockaded the interior of the spiracle. in this case, migration of the gas which led the spiracle since it prevented holding a lubricant in a spiracle with surface tension where the interior of a spiracle is blockaded — certainty — the release to the exterior which passes spiracles, such as air bubbles which it was highly carried out and were mixed in the lubricant, — certainty — it may be carried out highly.
[0023] In addition, this dynamic pressure liquid bearing equipment shall have the tip side circular slot of the hoop direction of method opening of the outside of the direction of a path into the hoop direction part in which the above-mentioned communication way of the location which faces the point of the sleeve section in the peripheral face of a shank does not exist.
[0024] It prevents the lubricant with which the tip side interface of the lubricant held at the radial bearing section was located with surface tension, and was held in the radial bearing section in that hoop direction part at the direction gap limb of the diameter of circular of the hoop direction formed between the inner skin of this tip side circular slot and the sleeve section flowing into the gap of the field by the side of the end face of a thrust section, and a rotation thrust side.
[0025] The pressure which moves to the lubricant which it is held according to factors, such as tolerance, assembly, and heat deformation, in the gap of a shank and the sleeve section at the time of rotation of a rotation sleeve object, and a tip side faces the direction gap limb of a end face side shaft alignment at the end face sense occurs. Since a gas is easy to be introduced into the radial bearing section from a tip side through the direction gap limb of the diameter of circular of the aforementioned hoop direction when the end face sense migration pressure exceeds a limit and continuation of the lubricant by the communication way breaks off, the migration by the side of the end face of a lubricant is suppressed more certainly.
[0026] Moreover, a rotation sleeve object has the annular thrust slot of method opening of the inside of the direction of a path which attaches this dynamic pressure liquid bearing equipment outside a thrust section (for example, annular thrust Itabe). The part which the field by the side of the end face of a thrust slot and the field by the side of a tip are made into a rotation thrust side, respectively, and the field by the side of the tip of a thrust section and the rotation thrust side by the side of a tip face, It shall have the thrust bearing section into both parts which the field by the side of the end face of a thrust section and the rotation thrust side by the side of a end face face. In that case, the lubricant of the tip side thrust bearing section and the end face side thrust bearing section shall continue through the lubricant between the periphery of a thrust section, and the periphery of a thrust slot. Moreover, it shall have the tip interface of a lubricant, this tip interface shall turn to the method of the inside of the direction of a path, it shall have the end face interface of a lubricant in the end face side of the radial bearing section, and this end face interface shall fix the both ends of a fixed axis to the method of the inside of the direction of a path of the tip side thrust bearing section toward a end face side at this time.
[0027] The dynamic pressure liquid bearing equipment of this invention can be used for a various machines instrument besides a motor.
(1-1) (1) As for dynamic pressure liquid bearing equipment, the interface of the method of the inside of the direction of a path of the lubricant with which the direction gap of an axial center is gradually expanded, and the direction gap limb of a end face side shaft alignment was held in the end face side thrust bearing section toward the method of the inside of the direction of a path at this direction gap limb of a end face side shaft alignment shall be located (claim 2).
[0028] in this case, the lubricant located in the direction gap limb of a end face side shaft alignment — surface tension — the method, i.e., the end face side thrust bearing section, side of the outside of the direction of a path — certainty — it can draw near highly and prevents a lubricant separating into the end face side thrust bearing section and an inner circumference side in the direction gap limb of a end face side shaft alignment.
(2) (1) Or (1-1) Dynamic pressure liquid bearing equipment The height from which the above-mentioned communication way is established in the field by the side of the end face of a thrust section, and projects in the

end face sense and which continues in the direction of a path mostly, It is desirable to have the slit section which is formed between rotation thrust sides, carries out opening to both hoop direction and the direction end face sense of an axial center in the direction toe of a path of the height, and can hold a lubricant with surface tension (claim 3).
[0029] The slit section can be made into the shape of a wedge which for example, the direction gap of a path expands gradually toward end face opening.
[0030] The pressure which moves to the lubricant which it is held according to factors, such as tolerance, assembly, and heat deformation, in the gap of a shank and the sleeve section at the time of rotation of a rotation sleeve object, and a tip side faces the direction gap limb of a end face side shaft alignment at the end face sense occurs. When the lubricant moves to the end face sense, in the slit section, it is easy to start the way piece of continuation of the lubricant by the communication way between the inner circumference section of the lubricant held at the end face side thrust-bearing section, and a shank and the point of the lubricant held in the gap of the sleeve section. Therefore, it is protected more certainly [that the amount of the lubricant which the lubricant held at the end face side thrust-bearing section moves to the radial bearing section superfluously, and carries out the lubrication of the end face side thrust-bearing section becomes / too little].
(3) (1) ** (1-1) Or (2) Dynamic pressure liquid bearing equipment The tip side radial bearing section to which the tip side approached the gap of the field by the side of the end face of a thrust section, and a rotation thrust side as the radial bearing section, It has the end face side radial bearing section located in a end face side rather than the tip side radial bearing section. Between said tip side radial bearing section and the end face side radial bearing section It has the direction gap limb of the diameter of middle with the larger direction gap of a path of the peripheral face of a shank, and the inner skin of the sleeve section than both the radial bearing section. The direction gap limb of the diameter of middle The 1st gap limb which the direction gap of a path expands gradually toward a end face side from said tip side radial bearing section, While having the 2nd gap limb which the direction gap of a path expands gradually toward a tip side from said end face side radial bearing section and having an interface by the side of the end face of the lubricant held at the tip side radial bearing section in said 1st gap limb It has an interface by the side of the tip of the lubricant held at the end face side radial bearing section in said 2nd gap limb. It shall have the air hole which opens near pars intermedia and the exterior of the 1st gap limb and the 2nd gap limb in the direction gap limb of the diameter of middle for free passage at least at the time of rotation of a rotation sleeve object in said fixed axis.
[0031] The 1st gap limb and the 2nd gap limb in the direction gap limb of the diameter of middle do not require not necessarily adjoining. For example, the direction gap of a path may have the fixed part between the 1st gap limb and the 2nd gap limb.
[0032] When the peripheral face of a shank reduces the diameter gradually toward a end face side and a tip side, respectively, as for the 1st gap limb and the 2nd gap limb in the direction gap limb of the diameter of middle, it is desirable that the direction gap of a path shall be expanded gradually.
[0033] A lubricant is stored by the 1st gap limb and the 2nd gap limb. In the tip side radial bearing section or the thrust-bearing section, in the end face side radial bearing section, when lubricants decrease in number according to evaporation, omission by the impact, etc., the lubricant with which the lubricant stored by the 1st gap limb was stored in the 2nd gap limb by the tip side radial bearing section is supplied to the end face side radial bearing section, respectively. A gas is introduced into the direction gap limb of the diameter of middle through an air hole with supply of a lubricant.
[0034] Moreover, an expanded part of the air bubbles by excessive air bubbles, a temperature rise, an atmospheric-pressure fall, etc. which were mixed in the lubricant etc. may be released to the passage exterior in an air hole.
[0035] As for this air hole, it is desirable that being held with surface tension (capillarity) in an air hole after the lubricant has blockaded the interior of that air hole shall be the cross-section size prevented. in this case — since it prevents holding a lubricant in an air hole with surface tension where the interior of an air hole is blockaded — gaseous installation — certainty — the air bubbles which it was highly carried out and were mixed in the lubricant — an air hole — leading — certainty — it may be released outside highly.
[0036] The number of openings to the number, the direction gap limb of the diameter of middle, or the exterior of an air hole is 1 or 2, respectively. It can consider as the above.
(3-1) (3) Dynamic pressure liquid bearing equipment It has the direction gap limb of the diameter of a end face which the direction gap of a path between a shank and the sleeve section expands to the end face side of the end face side radial bearing section gradually toward a end face side. The end face interface at the time of the

nonrotation of the lubricant held at the end face side radial bearing section shall be located in this direction gap limb of the diameter of a end face. Furthermore, have the interface retracting mechanism drawn in rotation of a rotation sleeve object with this end face interface to a tip side, and external opening of the above-mentioned air hole is located near the boundary section of the end face side radial bearing section and the direction gap limb of the diameter of a end face. It is desirable that shall carry out opening into a lubricant at the time of nonrotation, and it shall be well-informed about the open air at the time of rotation of a rotation sleeve object.

[0037] If a rotation sleeve object rotates, a centrifugal force will act on the lubricant with which the gap of a fixed axis and a rotation sleeve object was filled up. Therefore, the lubricant currently held with surface tension so that a end face interface might be located in the direction gap limb of the diameter of a end face at the time of nonrotation will be in the condition of being easy to dissipate by [which ooze to a end face side further according to an operation of said centrifugal force, or leaks out] depending especially or dropping out by the impact. However, since the end face interface of a lubricant is drawn in a tip side by the interface retracting mechanism from the location at the time of nonrotation with rotation of a rotation sleeve object, it is hard coming to generate dissipation by exudation or exsorption of the lubricant by operation of a centrifugal force, or dissipation by dropping out by the impact.

[0038] The above-mentioned interface retracting mechanism establishes a dynamic pressure generating slot in the end face side radial bearing section, and the dynamic pressure generated in a lubricant by the dynamic pressure generating slot with rotation of a rotation sleeve object shall incline toward the tip side approach in the end face side radial bearing section, and shall become high. For that purpose, the structure where eccentricity of the dynamic pressure generating slot was carried out to the direction tip approach of an axial center for example, in the end face side radial bearing section can be adopted. In addition, as a dynamic pressure generating slot of a dynamic pressure generating slot, a herringbone slot etc. can be used, for example. Moreover, a dynamic pressure generating slot can be established in both a shank, and sleeve both [either or].

[0039] External opening of the air hole to which one opening is located near [in the direction gap limb of the diameter of middle] the pars intermedia of the 1st gap limb and the 2nd gap limb is located near the boundary section of the end face side radial bearing section and the direction gap limb of the diameter of a end face, a end face interface is drawn in a end face side radial bearing section side by the interface retracting mechanism at the time of rotation of a rotation sleeve object, and opening of said external opening is carried out to the open air.

[0040] Since it is drawn in a end face side radial bearing section side by the interface retracting mechanism at the time of rotation of a rotation sleeve object and external opening of an air hole carries out opening into a lubricant at the time of nonrotation when the lubricant held at the tip side radial bearing section or the end face side radial bearing section may ooze to external opening of an air hole through an air-hole inside, it prevents a lubricant exuding to the exterior further anyway.

(3-2) (3) Or (3-1) Dynamic pressure liquid bearing equipment Near the boundary section with the 1st gap limb, the end face side of the tip side radial bearing section in the peripheral face of a shank It is desirable to have the air hole which has the end face side circular slot of the hoop direction of method opening of the outside of the direction of a path, and opens the end face side circular slot and exterior for free passage at least at the time of rotation of a rotation sleeve object in said fixed axis (claim 4).

[0041] This air hole is (3). You may have an air hole and a public area. The cross-section size with a desirable air hole is (3). It is as having described.

[0042] The end face side circular slot and the exterior of the hoop direction which it has near the boundary section with the 1st gap limb are open for free passage at least with an air hole at the time of rotation of a rotation sleeve object the end face side of the tip side radial bearing section in the peripheral face of a shank. Therefore, when the pressure which a lubricant moves to the tip sense occurs and the lubricant moves to the tip sense according to factors, such as tolerance, assembly, and heat deformation, in the tip side radial bearing section at the time of rotation of a rotation sleeve object, a gas is introduced into tip side radial bearing circles from a end face side through an air hole and a end face side circular slot. since the movement magnitude of a lubricant is comparatively alike, and is introduced into the interior of the tip side radial bearing section in a small phase, the lubricant migration pressure of the tip sense decreases by that cause and this gas comes to balance, the movement magnitude by the side of the tip of a lubricant is comparatively alike, and is stopped small.

(4) (1) (1-1) (2) (3) Or (3-1) Dynamic pressure liquid bearing equipment A rotation sleeve object has the annular thrust slot of method opening of the inside of the direction of a path attached outside a thrust section. The part which the field by the side of the end face of the thrust slot and the field by the side of a tip are made into a

rotation thrust side, respectively, and the field by the side of the tip of a thrust section and the rotation thrust side by the side of a tip face, It has the thrust bearing section into both parts which the field by the side of the end face of a thrust section and the rotation thrust side by the side of a end face face. The lubricant of the tip side thrust bearing section and the end face side thrust bearing section It continues through the part between the periphery end face of a thrust section, and the periphery section of a thrust slot. It has the dynamic pressure developmental mechanics which produces the pressure distribution which the lubricant in each thrust-bearing section moves to each thrust-bearing section by the side of a tip and a end face from an inner circumference side with rotation of a rotation sleeve object to a periphery side. Have the tip interface of a lubricant in the method of the inside of the direction of a path of the tip side thrust bearing section, and it sets at the periphery end face of a thrust section, and a list into the part by the side of the inner circumference of the thrust bearing section by the side of a tip and a end face among the field by the side of the tip of a thrust section, and the field by the side of a end face. It shall have the lubricant circuit which carries out opening into the lubricant with which the gap of a thrust slot and a thrust section was filled up, respectively in thrust circles (claim 5).

[0043] The above-mentioned dynamic pressure developmental mechanics establishes a dynamic pressure generating slot in the thrust-bearing section by the side of a tip and a end face, respectively, and the dynamic pressure generated in a lubricant by the dynamic pressure generating slot with rotation of a rotation sleeve object shall incline toward the periphery side in the thrust-bearing section by the side of the tip and a end face, and shall become high. For that purpose, when a herringbone slot is used, for example as a dynamic pressure generating slot of a dynamic pressure generating slot, the structure where eccentricity of the core of the dynamic pressure generating slot was carried out to the periphery side in the thrust bearing section can be adopted. Moreover, a dynamic pressure generating slot can be established in both a thrust section, and thrust both [either or].

[0044] If a rotation sleeve object rotates, the lubricant in each thrust bearing section will move to a periphery side from an inner circumference side, and, subsequently it will flow and circulate [from the periphery end face of a thrust section] through it through the lubricant circuit of thrust circles into the part by the side of the inner circumference of the thrust bearing section by the side of a tip and a end face among the field by the side of the tip of a thrust section, and the field by the side of a end face. Thus, when a lubricant circulates, the air bubbles in the lubricant with which the gap of a thrust slot and a thrust section was filled up, especially the air bubbles by the side of the periphery of the thrust bearing section are released from the interface of the lubricant located in the method of the inside of the direction of a path of the tip side thrust bearing section by the open air.

[0045] A lubricant circuit can be made into 1 or 2 or more.

[0046] To the periphery end face of a thrust section, it is desirable that shall have the introductory slot of the hoop direction of method opening of the outside of the direction of a path, and opening of a lubricant circuit shall be located in the introductory slot. It is for a lubricant to make it be easy to be introduced into opening of a lubricant circuit with air bubbles. Although an introductory slot shall be crossed to the perimeter, you may have it partially in a hoop direction.

(5) the motor of this invention — the above (1) (2) (3) ** (3-1) Or (4) It has dynamic pressure liquid bearing equipment, and a rotation sleeve object rotates as Rota (claim 6).

[0047] A motor can be used for this motor as various motors besides the spindle motor for driving record media including optical disks, such as magnetic disks, such as a hard disk, a magneto-optic disk, CD-ROM, CD-R, CD-RW, and DVD, especially a disc-like record medium.

[0048]

[Embodiment of the Invention] The gestalt of operation of this invention is explained referring to drawing 1 thru/or drawing 3 .

[0049] The lower part perspective view of a rotation thrust plate [in / in the sectional view of the spindle motor for the hard disk drive whose drawing 1 was equipped with the dynamic pressure liquid bearing equipment as an example of the gestalt of operation of this invention (motor), and drawing 2 / the dynamic pressure liquid bearing equipment of the spindle motor], and drawing 3 are the enlarged drawings near the right-hand side section of the rotation thrust plate in drawing 1 . However, the rotation thrust plate in drawing 1 and its periphery correspond to the I-O-I line in drawing 2 .

[0050] By carrying out fitting immobilization of the lower limit section (end face section) of the fixed axis 12 at the fitting hole of the base 10 of a spindle motor, set-up immobilization of the fixed axis 12 is carried out. The

supporter 13 holding the stator core 16 around which the stator coil 14 was wound is being fixed to the periphery side of the fixed axis 12 in a base 10 top.

[0051] The fixed axis 12 comes to have annular tabular fixed thrust plate 12b (thrust Itabe) by which outer fitting immobilization was carried out in the shape of the same axle in the upper part of fixed shank material 12a (shank) and fixed shank material 12a of the vertical direction. Outer fitting of the rotation sleeve object 18 which consists of rotor hub 18a and rotation thrust plate 18b is carried out to the fixed axis 12.

[0052] Outer fitting maintenance of the hard disk is carried out at the periphery section of the shape of a cylinder side of rotor hub 18a. rotor hub 18a — the bottom half section makes the shape of a double pipe of the sleeve section 18a1 by the side of inner circumference, and the Rota magnet attaching part 18a2 by the side of a periphery mostly. The sleeve section 18a1 is carrying out sleeve fitting among fixed shank material 12a at the part between fixed thrust plate 12b and a base 10. Sequential diameter expansion of the upper bore of the sleeve section 18a1 is carried out toward the upper part (tip side) to the Nakauchi diameter 18a3 and the Ochi diameter 18a4. By carrying out inner fitting immobilization of the rotation thrust plate 18b at the lower limit section of this Ochi diameter 18a4, the annular thrust slot 20 of method opening of the inside of the direction of a path is formed at the inner circumference side of the Nakauchi diameter 18a3, and this thrust slot 20 is being attached outside fixed thrust plate 12b. Inner fitting immobilization of the annular tabular seal member 22 is carried out at the rotation thrust plate 18b bottom in the Ochi diameter 18a4.

[0053] Since the lower limit section can be fixed to a base 10 and it can fix the upper limit section of fixed shank material 12a to the lid (not shown) of hard disk drive etc., the fixed axis 12 can realize stable rotation of the rotation sleeve object 18.

[0054] Inner fitting immobilization of cylindrical Rota York 24 made from a ferromagnetic ingredient is carried out, inner fitting immobilization of the cylinder-like Rota magnet 26 is carried out in the cylindrical Rota York 24, a stator core 16 and the direction opening of a path are separated in the Rota magnet attaching part 18a2 of rotor hub 18a, and it is faced. Rota consists of the rotation sleeve object 18, cylindrical Rota York 24, and a Rota magnet 26.

[0055] The part which faces the lower limit section of the sleeve section 18a1 among the periphery sections of fixed shank material 12a goes caudad, the diameter of it is reduced in the shape of a taper, and the direction gap limb 28 of the diameter of a lower limit (end face) which the gap between the inner skin of the sleeve section 18a1 goes caudad, and expands gradually by this is formed. Oil-repellent processing of spreading of an oil repellent agent etc. is performed to the lower limit section of the inner skin of the sleeve section 18a1.

[0056] The bottom inner circumference flank of the top side of the thrust slot 20 inclines upward toward the inner direction, and the direction gap limb 29 of a top (tip side) axial center which a gap expands gradually is formed between the top faces of fixed thrust plate 12b. The annular space section 31 to which the gap was expanded is further formed in the direction of an axial center, and the direction of a path at the inner circumference side of the direction gap limb 29 of a top axial center of the annular crevice of the inner skin of rotation thrust plate 18b which faces the peripheral face of fixed shank material 12a, and it. Oil-repellent processing of spreading of an oil repellent agent etc. is performed to the peripheral face of fixed shank material 12a which separates the inner skin of rotation thrust plate 18b, and the comparatively narrow opening of it and the direction of a path, and faces [above the annular space section 31].

[0057] Moreover, the annular lubricating oil prehension slot 30 of method opening of the inside of the direction of a path is formed between the seal member 22 and rotation thrust plate 18b, and oil-repellent processing of spreading of an oil repellent agent etc. is performed to the peripheral face of fixed shank material 12a which separates the inner skin of the seal member 22, and the comparatively narrow opening (for example, 50 micrometers) of it and the direction of a path, and faces.

[0058] The bottom inner circumference flank 12b1 of fixed thrust plate 12b inclines upward toward the inner direction, and the direction gap limb 32 of a bottom (end face side) axial center which a gap expands gradually is formed between the bottom sides of the thrust slot 20.

[0059] It has the communication protruding line section 34 of the direction of a path, respectively in two in the bottom inner circumference flank 12b1 of fixed thrust plate 12b which separated the central angle 180 degrees. The inferior surface of tongue of the communication protruding line section 34 is parallel to the bottom periphery flank 12b2 of fixed thrust plate 12b, and the both-sides side of a hoop direction is extended a little toward the upper part. The inner end face of the communication protruding line section 34 has the slit section 36 in which the direction gap of a path goes caudad, is gradually expanded, and makes the shape of a wedge between the peripheral faces of fixed shank material 12a by going caudad from the inner circumference edge of the bottom

inner circumference flank 12b1, and inclining in the method of the outside of the direction of a path. Between the bottom sides of the communication protruding line section 34 and the thrust slot 20, the communication way 37 of the direction of a path is formed.

[0060] The ring bone slot 38 (slots for dynamic pressure generating other than a ring bone slot can also be used.) is established in the top face and inferior surface of tongue of fixed thrust plate 12b to those for dynamic pressure generating, respectively. The top (tip side) thrust bearing section 40 and the bottom (end face side) thrust bearing section 42 are constituted between the top side (inferior surface of tongue of rotation thrust plate 18b) of the thrust slot 20, and the bottom side of the thrust slot 20, respectively.

[0061] The need part of the gap of the fixed axis 12 and the rotation sleeve object 18 is filled up with the lubricating oil 44. The top interface and bottom interface of a lubricating oil 44 with which the thrust slot 20 and the gap of fixed thrust plate 12b were filled up turn to the method of the inside of the direction of a path in the direction gap limb 29 of a top axial center, and the direction gap limb 32 of a bottom axial center, respectively. the lubricating oil 44 located in the direction gap limb 32 of a bottom axial center since a gap expands gradually the direction gap limb 32 of a bottom axial center toward the inner direction — surface tension — the method 42, i.e., the bottom thrust bearing section, side of the outside of the direction of a path — certainty — it can draw near highly and prevents a lubricating oil 44 separating into the bottom thrust bearing section 42 and an inner circumference side in the direction gap limb 32 of a bottom axial center.

[0062] Parts other than communication way 37 are the gas parts 46 among the inner circumference sections of the direction gap limb 32 of a bottom axial center. Between the bottom sides of the communication way 37, i.e., the communication protruding line section 34 and the thrust slot 20, the upper limit section of the lubricating oil 44 to which the lubricating oil 44 was held surface tension, and was held by this in the gap of fixed shank material 12a and the sleeve section 18a1, and the inner circumference section of the lubricating oil 44 held at the bottom thrust bearing section 42 continue.

[0063] It passes, the ring bone slot 38 is formed so that the core of the dynamic pressure may carry out eccentricity to the periphery side in the upper thrust bearing section 40 and the bottom thrust bearing section 42, and the pressure distribution which the lubricating oil 44 in the vertical thrust bearing section 40–42 moves to a periphery side from an inner circumference side with rotation of the rotation sleeve object 18 are produced.

[0064] It has direction slot of axial center 48a which forms a spiracle 48 in two places which separated the central angle from the communication protruding line section 34 in the inner skin of fixed thrust plate 12b 90 degrees between the peripheral faces of fixed shank material 12a. A spiracle 48 opens the gas part 46 and the exterior for free passage through a gap with the peripheral face of fixed shank material 12a, the inner skin of rotation thrust plate 18b, and the inner skin of the seal member 22 in annular space section 31 list.

[0065] It has the lubricating oil circuit 50 which carries out opening into the lubricating oil 44 with which the periphery end face of fixed thrust plate 12b and the list were filled up in the thrust slot 20 and the gap of fixed thrust plate 12b in the part by the side of the inner circumference of the vertical thrust bearing section 40–42, respectively among the field of a fixed thrust plate 12b top, and the lower field in fixed thrust plate 12b. In the periphery end face of fixed thrust plate 12b, it has the introductory slot 52 of the shape of a cross-section segment of method opening of the outside of the direction of a path covering the perimeter, and opening of the lubricating oil circuit 50 is located in the introductory slot 52.

[0066] If the rotation sleeve object 18 rotates, the lubricating oil 44 in the vertical thrust bearing section 40–42 will move to a periphery side from an inner circumference side, and, subsequently it will flow and circulate [from the periphery end face of fixed thrust plate 12b] through it through the lubricating oil circuit 50 in fixed thrust plate 12b into the part by the side of the inner circumference of the vertical thrust bearing section 40–42 among the field of a fixed thrust plate 12b top, and a lower field. Thus, when a lubricating oil 44 circulates, the air bubbles in the lubricating oil 44 with which the thrust slot 20 and the gap of fixed thrust plate 12b were filled up, especially the air bubbles by the side of the periphery of the vertical thrust bearing section 40–42 are released from the interface of the lubricating oil 44 located in the method of the inside of the direction of a path of the upper thrust bearing section 40 by the open air.

[0067] The ring bone slot 54–55 (slots for dynamic pressure generating other than a ring bone slot can also be used.) is established in those for dynamic pressure generating, respectively, and the upper radial bearing section 56 and the bottom radial bearing section 58 are constituted between the peripheral faces of fixed shank material 12a by the upper part and the lower part of inner skin of the sleeve section 18a1, respectively. Among those, the ring bone slot 55 has arrived at the upper part of the direction gap limb 28 of the diameter of a lower limit to

those for dynamic pressure generating of the bottom radial bearing section 58, and it is established in them so that the core in the direction of an axial center of the dynamic pressure through which it passes and which is generated to a lubricating oil 44 by the ring bone slot 55 may become upper approach from the core in the direction of an axial center of the bottom radial bearing section 58 with rotation of the rotation sleeve object 18. The gap of the inner skin of the sleeve section 18a1 and the peripheral face of fixed shank material 12a is usually several micrometers in the vertical radial bearing section 56-58.

[0068] It has the bottom circular slot 59 of the hoop direction which carries out opening to the quadrant periphery part (hoop direction part in which the communication way 37 does not exist) of the hoop direction centering on a spiracle 48 at the method of the outside of the direction of a path at the cross-section abbreviation configuration for V characters among the upper limit sections of a part which face the sleeve section 18a1 in fixed shank material 12a. The bottom circular slot 59 is formed more shallowly than the depth of the annular crevice 60.

[0069] Fixed shank material 12a has the annular crevice 60 of the shape of a cross-section segment of method opening of the outside of the direction of a path between the vertical radial bearing sections 56-58 in the peripheral face. Between the annular crevice 60 and the peripheral face of fixed shank material 12a, the direction gap limb 62 of the diameter of middle is formed. The Uema spare time limb (the 1st gap limb) which the direction gap limb 62 of the diameter of middle goes caudad from the upper radial bearing section 56, and the direction gap of a path expands gradually constitutes the Johan section, and the bottom gap limb (the 2nd gap limb) which the direction gap of a path expands gradually toward the upper part constitutes the bottom half section from the bottom radial bearing section 58.

[0070] Besides, it has an interface by the side of the lower limit of the lubricating oil 44 held in the upper radial bearing section 56 at the gap limb, and has an interface by the side of the upper limit of the lubricating oil 44 held in the bottom radial bearing section 58 in a bottom gap limb.

[0071] To the direction gap limb of the diameter of circular of the hoop direction formed between the inner skin of the bottom circular slot 59 and the sleeve section 18a1 Among the lubricating oils 44 held at the upper radial bearing section 56, the upper limit side interface of the hoop direction part corresponding to the bottom circular slot 59 is located with surface tension, and sets into the hoop direction part. It prevents the lubricating oil 44 held at the upper radial bearing section 56 flowing into the direction gap limb 32 of a bottom axial center.

[0072] Moreover, the lower limit side interface of the lubricating oil 44 held at the bottom radial bearing section 58 is located in the direction gap limb 28 of the diameter of a lower limit.

[0073] It has the bottom circular slot 63 of the hoop direction covering the quadrant periphery which carries out opening to the cross-section abbreviation configuration for V characters at the method of the outside of the direction of a path near the boundary section with the Uema spare time limb of the direction gap limb 62 of the diameter of middle the lower limit side of the upper radial bearing section 56 in the peripheral face of fixed shank material 12a. The bottom circular slot 63 is formed more shallowly than the depth of the annular crevice 60.

[0074] It has the air hole 64 to which external opening 64a is located in fixed shank material 12a near the boundary section of the bottom radial bearing section 58 and the direction gap limb 28 of the diameter of a lower limit. Opening of the 1st interior opening 64b of an air hole 64 is carried out near the pars intermedia of the Uema spare time limb in the direction gap limb 62 of the diameter of middle, and a bottom gap limb. Opening of the 2nd interior opening 64c of an air hole 64 is carried out to the bottom circular slot 63.

[0075] the lower limit side interface of the lubricating oil 44 held in the bottom radial bearing section 58 at the time of rotation of the rotation sleeve object 18 — that of the bottom radial bearing section 58 — the ring bone slot 55 — the upper part of the direction gap limb 28 of the diameter of a lower limit — or it is drawn further up and opening of the external opening 64a of an air hole 64 is carried out to the open air.

[0076] A lubricating oil 44 is stored by the Uema spare time limb in the direction gap limb 62 of the diameter of middle, and the bottom gap limb. In the upper radial bearing section 56 or the bottom radial bearing section 58, when lubricating oils 44 decrease in number according to evaporation, omission by the impact, etc., the lubricating oil 44 to which the lubricating oil 44 stored by the Uema spare time limb of the direction gap limb 62 of the diameter of middle was stored in the bottom gap limb of the direction gap limb 62 of the diameter of middle by the tip side radial bearing section is supplied to the end face side radial bearing section, respectively. The open air is introduced into the direction gap limb 62 of the diameter of middle through an air hole 64 with supply of a lubricating oil 44.

[0077] Between the inner circumference section of the lubricating oil 44 held at the bottom thrust-bearing section 42, and fixed shank material 12a and the points of the lubricating oil 44 held in the gap of the sleeve

section 18a1 continues to the lubricating oil 44 held on the communication way 37. When it sets they to be [any of the bottom thrust-bearing section 42 and the upper radial bearing section 56] and lubricating oils 44 decrease in number according to evaporation, omission by the impact, etc., a lubricating oil 44 is supplied from bearing of another side through the communication way 37 to bearing to which lubricating oils 44 decreased in number. Therefore, inconvenient generating that the lack of a lubricating oil arises only about one bearing, and equipment forms a short life is prevented.

[0078] The upper radial bearing section 56 is designed so that imbalance to which the dynamic pressure of a lubricating oil 44 becomes high may be produced and made upper part approach a little with tolerance-zone extent.

[0079] The pressure which moves to the lubricating oil 44 which it is held in the upper radial bearing section 56 according to factors, such as tolerance, assembly, and heat deformation, at the time of rotation of the rotation sleeve object 18, and an upper limit side faces the direction gap limb 32 of a bottom axial center downward occurs, and the lubricating oil 44 can move downward. In that case, when a downward migration pressure exceeds a limit, it will act each other with a centrifugal force, surface tension, etc. to a lubricating oil 44 in the communication way 37, and continuation of the lubricating oil 44 by the communication way 37 between the inner circumference section of the lubricating oil 44 held at the bottom thrust-bearing section 42, and fixed shank material 12a and the point of the lubricating oil 44 held in the gap of the sleeve section 18a1 will break off. The slit section 36 makes easy to start the way piece of continuation of such a lubricating oil 44.

[0080] the amount of the lubricating oil 44 which the lubricating oil 44 held at the bottom thrust-bearing section 42 when continuation of the lubricating oil 44 by the communication way 37 broke off moves to the upper radial bearing section 56 superfluously, and carries out the lubrication of the bottom thrust-bearing section 42 becomes [too little] — certainty — it is protected highly. Moreover, if a lubricating oil 44 breaks off in this way and gases, such as air, are introduced into the upper radial bearing section 56 from an upper limit side, since a downward lubricating oil migration pressure will decrease by that cause and it will come to balance, migration to the lubricating oil 44 down side is suppressed. Under the present circumstances, since a gas is easy to be introduced into the upper radial bearing section 56 from an upper limit side through the bottom circular slot 59, migration in the lower part of a lubricating oil 44 is suppressed more certainly.

[0081] while the downward migration pressure to the lubricating oil 44 held in the gap of the above fixed shank material 12a and the sleeve section 18a1 rotates — or, if a rotation halt is solved Continuation of the lubricating oil 44 by the communication way 37 between the inner circumference section of the lubricating oil 44 held at the bottom thrust-bearing section 42, and fixed shank material 12a and the point of the lubricating oil 44 held in the gap of the sleeve section 18a1 may be recovered.

[0082] In addition, migration of gases, such as air, arises through a spiracle 48 with expansion or contraction of the direction gap limb 32 of a bottom axial center of a gas part.

[0083] Moreover, when the pressure which a lubricating oil 44 moves upward occurs and the lubricating oil 44 moves upward according to factors, such as tolerance, assembly, and heat deformation, in the upper radial bearing section 56 at the time of rotation of the rotation sleeve object 18, a gas is introduced from a lower limit side in the upper radial bearing section 56 through an air hole 64 and the bottom circular slot 63. since the upper part movement magnitude of a lubricating oil 44 is comparatively alike, and is introduced into the upper radial bearing section 56 interior in a small phase, a upward lubricating oil migration pressure decreases by that cause and this gas comes to balance, the movement magnitude to the upper part of a lubricating oil 44 is comparatively alike, and is stopped small.

[0084] Furthermore, if the rotation sleeve object 18 rotates, a centrifugal force will act on the lubricating oil 44 with which the gap of the fixed axis 12 and the rotation sleeve object 18 was filled up. Therefore, although the lubricating oil 44 currently held with surface tension will be in the condition of being easy to dissipate by [which ooze below further according to an operation of a centrifugal force, or leaks out] depending especially or dropping out by the impact so that a lower limit interface may be located in the direction gap limb 28 of the diameter of a lower limit at the time of nonrotation The lower limit side interface of the lubricating oil 44 held at the bottom radial bearing section 58 It is hard coming to generate dissipation by the upper part of the direction gap limb 28 of the diameter of a lower limit, exudation of the lubricating oil 44 by operation of a centrifugal force since it is drawn further up, or exsorption, or dissipation by dropping out by the impact by the ring bone slot 55 to that of the bottom radial bearing section 58.

[0085] In addition, the vertical physical relationship in the description about the gestalt of the above operation is only a thing for the facilities of the explanation based on drawing, and does not limit an actual busy condition etc.

[0086]
[Effect of the Invention] While inconvenient generating that the lack of a lubricant arises about either the end face side thrust-bearing section or the radial bearing section, and equipment forms a short life is prevented according to the dynamic pressure liquid bearing equipment and the motor of this invention, it prevents the amount of the lubricant which the lubricant held at the end face side thrust-bearing section moves to the radial bearing section superfluously, and carries out the lubrication of the end face side thrust-bearing section becoming [too little].
[0087] According to the motor equipped with the dynamic pressure liquid bearing equipment of claim 4, and it, the movement magnitude by the side of the tip of the lubricant of the tip side radial bearing section is small stopped in comparison.
[0088] According to the motor equipped with the dynamic pressure liquid bearing equipment of claim 5, and it, the air bubbles in the lubricant with which the gap of a thrust slot and a thrust section was filled up are released by the open air.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a sectional view about the spindle motor for a hard disk drive.
[Drawing 2] It is the lower part perspective view of a rotation thrust plate.
[Drawing 3] It is an enlarged drawing near the right-hand side section of the rotation thrust plate in drawing 1 .
[Drawing 4] It is a sectional view about the conventional example of the spindle motor for a hard disk drive.
[Description of Notations]
12a Fixed shank material
12b Fixed thrust plate
Twelveb1 Bottom inner circumference flank
18a1 Sleeve section
20 Thrust Slot
34 Communication Protruding Line Section
36 Slit Section
37 Communication Way
42 Bottom Thrust Bearing Section
44 Lubricating Oil

[Translation done.]

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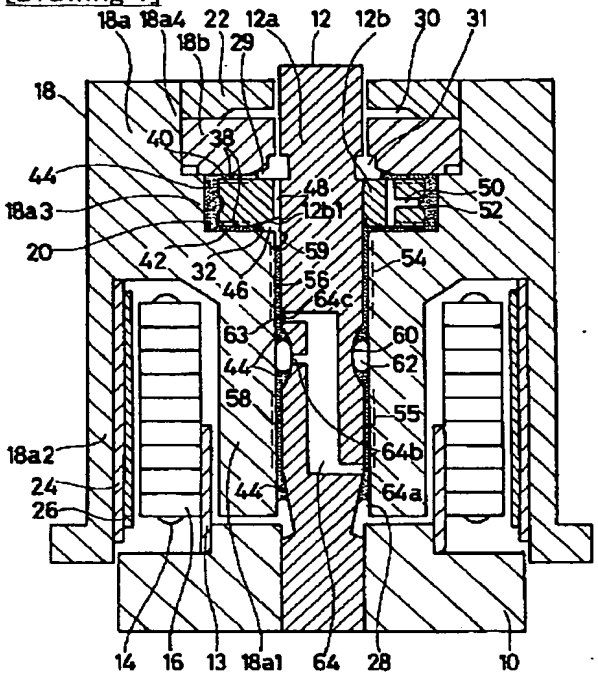
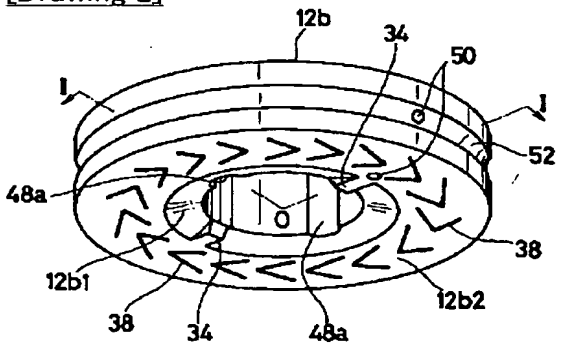
DRAWINGS

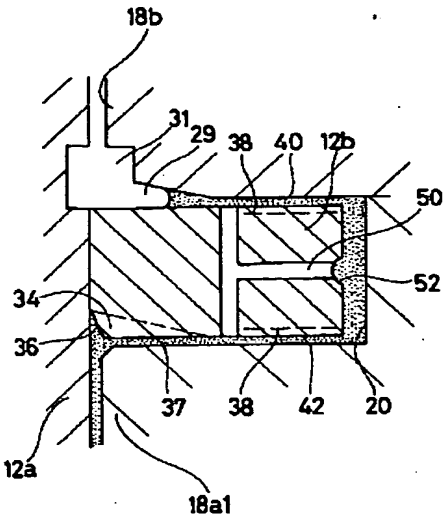
[Drawing 1]



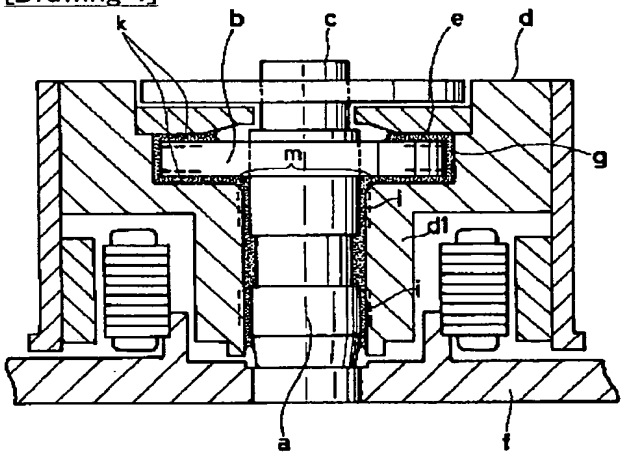
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]